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THE SCIENTIFIC MONTHLY

APRIL, 1923

THE CONSERVATION AND UTILIZATION OF NATURAL RESOURCES[1]

THE NATIONAL PROBLEM OF LAND RECLAMATION

By F. H. NEWELL

U. S. RECLAMATION SERVICE, WASHINGTON, D. C.

THE nation is committed to a policy of reclamation and use of the portions of its public and other lands which, having a tillable soil, are not available for farms until there has been a regulation of the water supply essential to the proper growth of plant life. The object of this reclamation, as stated by its advocates, is the making of small self-supporting farm homes. This object is summed up in a message from the Secretary of the Interior, Albert B. Fall, on the twentieth anniversary of the passage of the act in the words that "the success of the law must be measured by the extent to which the reclaimed lands are utilized in the making of self-supporting American homes."

The point emphasized in this policy of conservation and use of otherwise waste land is that the fundamental purpose is not merely the increase of material prosperity—the making of money through greater crop production—or even of adding to the food supply of the nation, important as this may be at the time. The real objective rises to a far higher level, that of ministering to what may be called, for lack of better words, the social and spiritual needs of the people through making possible the creation of the small self-supporting farm home, in which may be exemplified the American ideals of "life, liberty and the pursuit of happiness." It has long been urged by popular speakers and others that it is the citizenship of the farm home which forms the backbone of the

[1] Papers presented before the Section of Social and Economic Sciences of the American Association for the Advancement of Science at the Boston meeting, December 27 to 30, 1922.

nation. It is upon the rural districts that we depend for stability of government and business institutions. We look to the country vote to offset the threat of Bolshevism in the cities. Our Constitution is based upon the assumption that a considerable proportion of the voters of the country are tax-paying citizens who own their homes or at least have a direct interest in the support of our governmental institutions. When the time arrives, as it threatens to do, that the great majority of the voters have no proprietary interest in anything beyond an automobile, when they believe that it is the landlord who must pay the taxes, then their interest in the economy and efficiency of public affairs wanes to an extent dangerous to any government.

Under such assumptions a reclamation act applicable to the sparsely settled, arid western states was urged by President Roosevelt in his first message to Congress in 1901; and on June 17, Bunker Hill Day, in 1902, he attached his signature to this act, marking a distinct departure in American policy.

Up to this time the public lands had been sold at nominal prices or given away on condition of settlement and cultivation. Now, however, with the rapid disappearance of these public lands, a new policy was adopted—that of practically creating new available lands by reclaiming such lands and removing the natural obstacles; in other words, by extending internally the territories of the United States.

Funds were provided for this reclamation by setting aside the proceeds of the disposal of public lands; in twenty years these proceeds have amounted to $105,000,000. They have been supplemented, and a loan of $20,000,000 has been added to them, so that over $130,000,000 has been made available. Most of this has been invested in the construction of works for the storage of flood waters, the building of canals to carry this water to the lands and the digging of ditches to drain away excess water. About thirty thousand farm units or opportunities for the creation of thirty thousand farm homes on the land have been created. These have been rapidly taken up, the land, so far as it is in public ownership, being given away on condition of settlement, cultivation and repayment of the construction charge. The money invested by the government in the building of the works is to be returned without profit or interest, and in instalments covering 20 years, without interest.

All of the works have been completed to a point where self-supporting small farm homes have been established, and there has been produced from these lands a gross value of crops aggregating $475,000,000. To this should be added the revenue from livestock. It should also be borne in mind that many structures have been

built in part and are being completed as rapidly as funds are available; and that most of the farmers have not yet brought under full cultivation all of the lands in their possession. Development of a new pioneer country takes time and demands infinite patience as well as hard labor and self-denial.

Enough has been done in the arid western states to show what can be accomplished as need arises in other parts of the country. While the government does not own any considerable area of land in the country east of Kansas, yet there are waste, or unused lands, which may be made available under similar methods.

For example, throughout the length and breadth of the country, from Maine to Louisiana and from Minnesota to Florida, are great tracts of cut-over lands or abandoned areas, where, because of interstate or other complications, it has not been possible to provide adequate drainage, or to get the land, with fairly fertile soil, into condition for settlement. The owners of these lands—especially of the cut-over forest lands—are feeling the burden of the taxation levied for the building of good roads and bridges, the maintenance of community schools, the erection of court houses and other public buildings. Some of this land is being sold for taxes. Most of it should be kept in permanent forest, but until the people awaken to the necessity of developing the policy for keeping the lands in forests, the lands must necessarily deteriorate.

When mention is made of the possibility of the government reclaiming or making available for settlement any of these cut-over lands, there arises at once a hysterical outburst that this is merely a scheme to help the wealthy lumbermen to unload worthless land upon the government. It is loudly declared that the government is always victimized in any deal of this kind, and that any man who advocates the development of these unused lands and the creation of small farm homes on the portions which have fertile soil must, necessarily, be in the pay of the lumbermen!

We can avoid this talk by stating at the outset that it is practicable for the government to adopt a policy of land reclamation without the necessity of buying great areas of land or of enriching the owners of cut-over lands. It is possible for the government to act as a trustee, and to pass the title of the reclaimed lands at prices agreed upon in advance directly from the present owners to the settlers who may establish homes thereon, and to see to it that they are not robbed in the process.

Dismissing such fear, it then becomes practicable to consider a broad program of land reclamation and use in the creation of farm homes in any or all parts of the United States where the climate, soil, social and market conditions are favorable.

First, however, must be considered the need of such farms:

We start out with the assumption that the stability of government and of business is dependent on the farm home; but, again, it may properly be asked as to whether there are not already enough of these and whether there is need for more. The present tendency, as shown by census reports, is that of a relative decrease; more and more families are going to the cities, big and little, because there they find not only larger wages, but more enjoyable surroundings. Some of our economists claim that the development of farming as an industry is bound to proceed along lines of greater intensity, of increasing product per individual and thus of requiring fewer individuals on the farm.

Carried to the logical conclusion, some publicists would go so far even as to assert that the best economic developments of the country will come about when farms are operated under the same methods as the Ford factories, or other great manufacturing concerns, where one or two men supply the brains, and where the work of each of the thousands of employees is minutely apportioned, consisting merely of turning a screw or pushing a wire through a hole. In line with this, these people urge that we should provide for the importation of Chinese or other Asiatic labor, with the provision that these coolies may be employed for a certain number of years, and then returned to their native countries; in other words, creating a condition of serfdom analogous in some of its methods to the slavery of olden times, under which great crops were produced. On the other hand, it is urged that no body of people should be admitted to the United States who are not qualified to make permanent homes and become assimilated with the people already here.

The whole spirit of our institutions is that the success of our government rests upon the citizens themselves, and that can not be raised higher than its source. For this reason it may well be questioned as to whether it is wise in the long run to encourage any type of manufacture or even of agriculture which requires inferior labor or creates the slum conditions prevalent in manufacturing centers.

In answer to the question as to whether we have enough small self-supporting farm homes, it may be shown that if the country continues to grow as in the past, and if there is a steady decrease in the proportion of such farm homes, even then there will be needed opportunities for new homes at a rate of say 300 per day. In other words, unless the number of farm homes is to decrease relatively, there must be some provision made for the future.

Where can these 300 new farm homes be found? Where can the country-minded young man and his wife look for a piece of

land? The answer from some of our economist friends is that he should not hope for a farm of his own at once; he should serve as a farm laborer, then as a renter, and, in the course of years, if he has worked skillfully and well, if he has been fortunate and at the same time thrifty, he may in middle age acquire some of the farm lands, the prices for which have been steadily advancing. In other words, he should climb the agricultural ladder, and, in the orderly course of events, arrive at the top, unless he falls off on the way up.

Other publicists ask whether it is desirable and necessary for these families to climb the agricultural ladder with all of its discouragements, due to the fact that for the greater part of his life the young man must be enriching the farm of some other man (assuming that he is not robbing it of its fertility). Can not society, or the government, in a country where half of the land is unused, make conditions such that the competent man may not be obliged to climb the ladder, typical of a temporary or unfinished structure? By coming in on the ground floor, he may begin at once to work on a farm of his own, where he may be able to gratify the passion for possession, and will be stimulated to think and work for himself in a way which he never would for any other man.

There is nothing in the physical conditions of the country nor its laws and precedents which forbid such ambitions. There already exist, in the results from the present Reclamation Act, ample precedent and inspiration for extending the benefits more widely. It is possible to say to every qualified seeker of a small farm home: "There is good land available which you can have upon such terms that you can make a home on the land, and need not risk your fortune and family in the laborious, unsatisfactory task of climbing the agricultural ladder from serfdom to ownership."

It is admitted, of course, that not every man who thinks he would like to have a small farm home is capable of making a success, no more than should it be assumed that every man who enlists in the army or seeks employment is capable of performing the duties or can pass the necessary tests for such employment. There must and should be for the good of the man himself tests which will eliminate those who are really unqualified. It frequently happens that the men who first apply are those who are habitually unsettled—the rainbow chasers, hunting the "pot of gold" and with no conception of the difficulties to be overcome.

Assuming, however, that good common sense is employed, with the guidance available from years of experience in reclamation

and settlement on the lands, then it is not merely practicable, but is a matter of sound public policy to improve the present machinery, and to extend to all parts of the United States the beneficent effects of a national reclamation act which will provide for the bringing into a condition suitable for cultivation all fertile lands now unused and making these available for the creation of small self-sustaining farm homes.

It might be urged that on similar grounds the government should provide equal opportunities for owners of small factories, for blacksmiths and for shoemakers. But there is a line which must be carefully drawn and rigidly observed, which is based on the fundamental distinction for the small farm home is not primarily a money-making institution, but is essentially a home for citizens.

The fear has been expressed that the country would thus be flooded, and millions or billions of dollars would thus be required for reclamation; in other words, that if the door of opportunity was once opened for the creation of such homes there would be such a rush and jam at the doorway as to practically upset all present social conditions. There need be little fear, however, in this direction. It is true the advocates of great schemes like those in the northwest, in the Columbia Basin, and in the southwest, on the Colorado, talk easily of hundreds of millions of dollars required for such reclamation; and that if amounts needed for all of the other work in all parts of the country is added up the amount exceeds the ability of the mind to grasp. As a matter of fact, the amount of money which could or would be granted by any Congress under any conceivable condition will always be far less than the actual needs, and the continual poverty in this respect will act as a brake or safeguard against entering into the wild undertaking so glowingly pictured by the extremist friends of the national policy.

In the long run the adoption of a policy of land reclamation and settlement on the part of the federal government should and will serve as more or less of a pace-maker for the activities of the states and semi-public corporations or municipalities created under the state laws for the drainage and development of various areas. It may be safely assumed that the federal government, as in the case of present irrigation enterprises, will continue to confine its efforts to those undertakings which are naturally beyond the reach of corporate or state effort.

In summing up, it may be said that of reclaimable public lands of the country, and of adjacent unused private lands with fertile soil, there are say 10,000,000 acres which may and should be pro-

vided with an adequate water supply. In other parts of the country there are bodies of land in private ownership, now unused, and which may be reclaimed by drainage and other means, aggregating at a conservative estimate 20,000,000 acres. In other words, there are perhaps 30,000,000 acres of reclaimable land which has been examined in whole or in part, and found to be suitable for the creation of small self-supporting farm homes, to the number of over a half million.

There are no obstacles in this reclamation which have not already been overcome; there is a need for the increase not merely in production on the lands already in use, but for the homes for which larger needs grow imperative. It would seem to be the part of wisdom to extend the Reclamation Act to permit the taking up of other land in a systematic, orderly manner, for the benefit of the states and of the nation.

PROBLEMS OF FLOOD CONTROL

By Brigadier General HARRY TAYLOR
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FLOOD control is a broad subject with many phases. Anything approaching a complete discussion of any one of the more important phases would take more time than I feel I can devote to it in the time assigned me, as it is only one of many important matters to be discussed at this meeting. I shall, therefore, try to give you a general view of the most important aspects of flood control. I shall refer at some length to the problem of flood control on the Mississippi River as that is the most important in the country, and shall quote Colonel C. McD. Townsend, formerly president of the Mississippi River Commission, who has devoted a large part of his life to the study of this subject.

It may be well to ask at the outset what are the causes of floods. The answer is, briefly, abnormal rainfall. This rainfall may be either in the shape of what is popularly known as a "cloudburst," such as occurred at Pueblo, Colorado, in June, 1921; in the shape of heavy, long-continued rains such as produced the floods in the lower Mississippi River in February and March last, or heavy rains falling on snow or frozen ground, such as produced the floods which devastated Dayton and other cities of Ohio a few years ago. Warm winds blowing on a heavy blanket of snow may also produce a serious flood. Floods of this character are most common in the Pacific Northwest where a warm southwest wind, known as a "Chinook" wind, occurs during the winter months and causes

the snow on the mountains to melt with great rapidity. The floods caused by the so-called cloudburst are usually local in character and commonly occur on small streams. Floods caused by the long, heavy rainfall usually cover a large territory and it often happens that such rainfall will produce a flood in the main stream when none of the tributaries are subject to excessive flood. This occurred during the past winter and spring in the lower Mississippi, when that stream carried one of the largest floods in history, while none of its tributaries carried an unusual flood, but all of the lower tributaries carried moderate quotas. The floods caused by rains falling on snow or frozen ground generally affect an area intermediate between the other two types.

Outside of the Mississippi Valley the people of the United States ordinarily give little thought to the control of floods. It is only when some serious flood occurs that attention is focused on the prevention of a repetition of the disasters caused by such flood, and then the matter is of extreme interest for a short time with all sorts of remedies proposed. Dayton, Ohio, is one exception. It is characteristic of the American people that when we suffer from any cause such as a flood, a contagious disease, or war, we are wildly enthusiastic for steps to prevent a repetition of the disaster, but as soon as the time of stress has passed we forget that trouble has occurred and delay taking the steps necessary to prevent a repetition. This is well illustrated by the present attitude of the American people toward the army. Five years ago there was nothing too good for the army. To-day, many seem to desire its absolute abolition, forgetting the fact that it is an insurance against trouble in the future. I wish that I could believe that we will never be involved in another war. I wish also that I could believe that we will never have a disastrous flood, but I am certain that floods will come until we know how to control the distribution of rainfall, and I am equally certain that the services of the army will be required in the future.

The control of floods appears to be considered by the majority of our people as a simple problem. It is true that different people have different solutions. The most common solutions are reforestation, reservoirs at the sources of the streams, levees, outlets or spillways, and straightening and enlarging river beds. We frequently have other solutions suggested, as, for example, one proposed to install boilers on the banks of the Mississippi River to evaporate the flood waters, thus causing clouds to form and produce rain over the middle west where needed.

In the solutions proposed the control of floods is quite commonly linked with other beneficial effects, most commonly with water-

power development. It is generally assumed that the same work which will control floods will produce power, improve navigation and provide drainage. One very troublesome problem that comes before the engineer department is the problem of the Fox River and Lake Winnebago, Wisconsin. At the outlet of Lake Winnebago are constructed two dams provided with gates for controlling the water outflow from this lake. The lake is surrounded by flat land over which the flowage rights were purchased and paid for by the United States some fifty years ago. Since that time these lands have been sold and the buyers in many cases have apparently made their purchases unaware of the rights of the government. Invariably during floods on this stream the people above the dams insist on the gates being opened so as to permit the water to flow out rapidly; the people below the dams insist on the gates being closed so as to prevent the water from coming down on them; power interests on the lower river desire to have the water retained and released during periods of low water for the purpose of developing additional power; for the benefit of navigation the flow should be as uniform as possible.

With reference to reforestation, I desire to say that I am a thorough believer in a sensible and sane system of reforestation. I believe that the proper exploitation of our few remaining forests and intelligent reforestation is one of the great needs of the country. Reforestation has sufficient merit in itself to stand on its own feet and should not be mixed up with flood control. The price of lumber to-day is a sufficient argument for planting trees without attempting to associate forestry with the climate or with flood conditions on our rivers.

There appears to exist in the public mind an impression that the prime cause of floods in this country has been the destruction of the forests, and that the surest way to prevent them is by reforestation. The influence of forests on stream flow has been extensively discussed both by European and American engineers since Gustav Wex, imperial and ministerial counselor and engineer of the improvement of the Danube River at Vienna in 1873, submitted a series of papers on the decrease of water in springs, creeks and rivers which were translated into English by the late General Weitzel, of the corps of engineers.

There is a great diversity of opinion on the subject, some maintaining that the cutting off of forests will ultimately convert Europe into a Numidian desert, while others claim that a moderate cutting of the forests even increases the rainfall. Whatever may be the theoretical principles involved, their practical application is fraught with great difficulty.

When a country acquires a population of 100,000,000 people, the forest primeval which existed when it was first settled has to disappear. It is all very well to bemoan the fact that if the black walnut which once covered the state of Ohio had not been destroyed and was sold as lumber at the present market rates it would equal the assessed valuation of the property of the state, but there have now been created the cities of Cleveland and Cincinnati, whose people can not live on black walnuts alone, but require grain and meat. The black walnut of Ohio has gone, never to return, and the same is true of the forests in other sections of the country. The fertile lands will not be taken away from the farmer. They are too valuable for raising potatoes and hogs. Only the poorer soils can be used for forest culture, and only a limited reforestation, then, is possible.

The effect of forests on rainfall in Europe has been carefully investigated, and the records at many European localities where the rain has been recorded for long periods fail to show any tendency to a pronounced change of fall in recent years.

The meteorological records of the United States have not been maintained a sufficient length of time to be of much value in solving the problem. The best existing data in this country of which I am aware are those for the Merrimack river, on which a daily record of the stage of the river has been observed since 1849, on a gauge established below the dam at Lawrence, Massachusetts. An exhaustive study of this stream was made about twelve years ago by Colonel Edward Burr, Corps of Engineers, and a report submitted by him which is published as a government document. Colonel Burr's conclusions as summarized for the basin of the Merrimack River were as follows:

> Deforestation of the basin continued progressively from the early settlements until about 1860-1870, and since that period forested areas have increased through natural causes by twenty-five per cent. or more of the entire basin, notwithstanding the continuance of lumbering operations.
>
> There has been no decrease in precipitation in the basin as a result of deforestation or any increase with the reforestation of twenty-five per cent. or more of its area. The precipitation for fifty to ninety years at points within the basin or within a few miles of its borders shows tendencies or cycles that bear no relation to the changes in forest areas.
>
> The average run-off through the river varies with the precipitation over its basin, and the percentage of run-off to precipitation is not appreciably affected by forest changes as great as twenty-five per cent. or more of the basin.
>
> The frequency of floods has not been decreased by reforestation or increased by deforestation.
>
> Exceptionally high floods have occurred at intervals without respect to forest conditions. Flood heights have not been decreased by forestation or increased by deforestation, and the principal characteristics of floods are

unaffected by forest changes. The duration of flood stages and the amount of run-off during such stages have not been affected adversely by deforestation or beneficially by reforestation.

Deforestation has not lessened the height of the river at low water or increased the duration of low-water periods, and the reforestation of twenty-five per cent. or more of the basin has not had any beneficial effect on low stages of the river.

Variations in stream flow are determined essentially by variations in climatic conditions which move in irregular cycles independent of forest changes.

Correct deductions as to climatic variations and as to varying conditions of stream flow may be expected only from the analysis of satisfactory records covering periods of sixty years or more, and conclusions drawn from records extending through forty years or less may and probably will be misleading or incorrect.

The greatest flood of the Mississippi at St. Louis occurred in 1844, the next largest in 1875. On the Great Lakes the high water of 1838 is the greatest on record. In the Ohio the flood of 1884 exceeded that of 1913 at Cincinnati; and that of 1832, while five feet lower at Cincinnati, was five feet higher at Pittsburgh than the 1913 flood. The gauge records at the bridges over the Upper Mississippi, which cover a period of thirty years, would indicate that the flow from Minnesota and Wisconsin, where the forests have been most extensively destroyed during the period, has been slightly improved, though the river shows signs of deterioration where it receives the flow from the prairie lands of Iowa and Illinois. They appear to confirm the conclusion of the European forestry authorities that the influence of forests on drainage is concealed by other causes more powerful in their effects.

It is, however, argued by some that with reforestation if the floods occasionally were high they would not be as frequent. Again let us search the records of the past. It is hopeless by reforestation to expect to reproduce the forest growth that existed at the close of the Civil War. Yet from 1857 to 1867 the Mississippi Valley was visited by a most remarkable series of great floods. These floods occurred as frequently as any that have been recorded since that time.

It requires from twenty to fifty years to produce a good forest growth, and over a century for the leaves of that forest to decay in sufficient quantities to produce the humus which will be satisfactory as an absorbent of rainfall. We are more vitally interested in the height that a river will attain in the next few months than in what will occur in the year 2022 or 2072. It is pertinent to this discussion to determine what would be the extent of the forest reservation which would be required to reduce the flood heights on the Mississippi River a given amount.

To solve this problem it is necessary to make certain assumptions, and for purposes of argument we will take it for granted that reforestation will reduce the flood discharge of a stream one half. The Mississippi flood of 1912 attained the greatest height of any then recorded at all gauge stations except at Vicksburg. That of January and February, 1913, while five feet lower at Cairo, was the next highest flood at Memphis and for a considerable distance along the river. We will endeavor by reforestation to reduce the flood of 1912 to the heights attained in the winter of 1913. For this purpose it will be necessary to reduce the maximum discharge of the river 500,000 second-feet. It will also be necessary to distribute this reduction among the tributaries, reducing the maximum discharge of the Missouri River from 900,000 to 700,000 second-feet, that of the upper Mississippi from 450,000 to 350,000, and that of the Ohio River from 1,400,000 to 1,200,000.

The flood discharge of the Missouri River at its headwaters is about one cubic foot per second per square mile of drainage area, and, if the reduction in discharge of one half is to be secured by reforestation two square miles of forests would be necessary for every second-foot of reduction of flood discharge, or 400,000 square miles of forests to reduce the discharge of the Missouri River 200,000 second-feet. At the headwaters of the upper Mississippi the ratio of flood discharge to drainage area is about two second-feet per square mile. A reduction of this discharge by one half would require a forest reservation of 100,000 square miles to reduce the floods of the upper Mississippi 100,000 second-feet. On the Ohio River the ratio is 6 to 1, and it would therefore require forests at the headwaters of the Ohio having an area of 33,000 square miles to reduce its flow 200,000 second-feet. In other words, to reduce the height of a flood at Memphis by reforestation at the headwaters of the river from that of 1912 to the next highest on record would require a forest reservation of about 533,000 square miles, an area exceeding that of the portions of Montana and Wyoming drained by the Missouri River and the states of North and South Dakota, the portion of Minnesota drained by the upper Mississippi River, and the states of Iowa, Wisconsin, Illinois and Indiana. But even such a forest reservation would afford only partial protection. Under the above assumptions, to prevent any overflow by reforestation would necessitate a practical abandonment of the valley for agricultural purposes and the development of an extensive irrigation system to produce tree growth in arid regions of the west.

It is therefore apparent that even under the above extreme assumptions reforestation as a means of reducing flood heights on the Mississippi River requires the conversion of too much farming

land into a wilderness to be practicable. The waste land that can profitably be converted into forest reservations is too limited in area to produce an appreciable effect on the floods.

Next to reforestation, reservoirs as a means of controlling floods appear to have the most advocates. The reservoir theory is particularly attractive, as we have before us in the Great Lakes a practical illustration of flood restraint by means of natural reservoirs. Reservoir control of the Mississippi River was discussed by Humphreys and Abbott in 1858, and on the upper Mississippi the corps of engineers has constructed the largest system of reservoirs for regulating rivers that has been built in any country. These reservoirs have been most successful, not only for increasing the low-water discharge of the Mississippi River above St. Paul, the purpose for which they were constructed, but also for reducing floods in that portion of the river.

There is, therefore, nothing novel in the proposition to control rivers by reservoirs. We have not only studied its advantages, but we know its limitations. Conditions are extremely favorable for reservoir construction at the headwaters of the Mississippi, but while they materially increase the low-water discharge at St. Paul and markedly reduce flood heights, yet one hundred miles farther down the river it is impossible to detect their influence during either high or low water.

A reservoir must be close to the locality to be benefited or its value rapidly diminishes, and this is a serious trouble with any project for regulating the lower Mississippi by reservoirs.

To have retained the Mississippi flood of 1912 within its banks would have required a reservoir in the vicinity of Cairo, Illinois, having an area of 7,000 square miles, slightly less than that of the state of Massachusetts, and a depth of about 15 feet, assuming that it would be empty when the river attained a bank-full stage.

Cairo is the logical location for a reservoir to regulate the discharge of the lower Mississippi. It will not only control the floods from the Ohio, but also the discharge from the Missouri and upper Mississippi. But if the reservoirs be transferred from the mouth of the tributaries to the headwaters their capacity must be largely increased. No two floods have the same origin, unless they are referred back to the Gulf of Mexico. If the prevailing winds in the early spring are from the southwest, the southern tributaries of the Ohio furnish the crest of the year's flood; if more nearly from the south, reservoirs will be required on the streams of Ohio, Indiana and Illinois; a slight varying of the wind will produce a flood in the upper Mississippi, while if it blows from the southeast the principal sources of trouble will be the Red, Arkansas and Missouri rivers. To control the flow of every stream in the Mis-

sissippi Valley by reservoirs is a pretty large job even for the United States Government, but that is what the control of the Mississippi during floods by reservoirs signifies.

The 1913 flood affords data for determining the effect of such a system of reservoirs. When, on April 2, 1913, the gauge at Cairo attained a height of 54 feet, there was flowing down the Mississippi River at least 2,000,000 cubic feet of water per second. It requires about eleven days for a flood wave to be transmitted the 966 miles between Pittsburgh, Pennsylvania, and Cairo. On March 22 the Pittsburgh gauge read 5.3 feet, which is produced by a flow in the Ohio River at that locality of about 15,000 second-feet. In ten days a flood travels the 858 miles between St. Paul, Minnesota, and Cairo. On March 2 the reading of the St. Paul gauge was 0.5 foot, corresponding to a discharge of the Mississippi of about 2,500 second-feet. In eight days the effect of a flood at St. Joseph, Missouri, is felt at Cairo. On March 25 the gauge at St. Joseph read minus 0.1 foot, representing a discharge of the Missouri River of about 17,000 second-feet. If a system of reservoirs had been constructed which would have prevented all flow from the Allegheny, the Monongahela, the Mississippi above St. Paul, and the Missouri above St. Joseph, it would have reduced the 2,000,000 second-feet discharge by the Mississippi River at Cairo on April 2 less than 35,000 second-feet.

The water which passed Cairo on the 2d of April came principally from the White and Wabash and the lower tributaries of the Ohio and, after the water of these rivers started to subside, the flood from Cincinnati, though increasing from 57 to 69 feet on the Cincinnati gauge, could increase flood heights at Cairo less than one foot. The flood of 30 feet at Pittsburgh on March 28 produced its effect on the Cairo gauge on April 8. It prolonged the flood without increasing its height.

The proposed system of reservoirs would have cost hundreds of millions of dollars and its effect on the flood height of the lower Mississippi could not possibly have exceeded six inches.

Great floods do not rise from average conditions, but from exceptional conditions such as are caused by a series of heavy rains rapidly succeeding one another. Each rainstorm starts down a stream a flood, the volume of which can be absorbed by a reservoir with comparatively little trouble, but if a second storm sweeps over the valley the reservoir, to be effective, must be emptied or its capacity doubled. To hold all the excess rainfall till low water would require reservoirs of enormous capacity. Economic considerations usually require that the reservoirs should be emptied as soon as the flood crest passes, in order to utilize the same space for a second rainfall; so that while reducing the crest of a flood

at a given locality they necessarily prolong the period during which the river remains at a high stage.

Reservoirs are necessary for municipal water supplies, for purposes of irrigation, for the development of power, and for feeders to canals. They can be successfully employed on small streams to diminish floods or increase the low-water flow. The trouble arises when an attempt is made to utilize them for too many purposes at the same time. There must be a paramount issue to which the others will be subsidiary.

If the main purpose is to supply a city with water, as a rule only the excess can be used for power development. In the case of the new water supply for San Francisco now under construction, a large amount of power will be developed, but in this case the main storage reservoir is over 4,000 feet above the city and the topography is such that at one point the supply line drops about 2,000 feet in a nearly vertical line, giving an excellent opportunity for a power development at a minimum expense and without interfering with the main object of the construction. If the dams are constructed to produce power, the reduction of floods and the improvement of river navigation must be subordinate thereto. Water required for irrigation can be used to develop power when the dam of the storage reservoir is given a greater height than is necessary for its flow over the land to be reclaimed.

During the next decade there will be an enormous development of reservoirs, both for irrigation and for power purposes, which I hope will be utilized to correct man's folly and prevent many disasters similar to those which have occurred in the past.

Levees, properly located and constructed, are an effective means of protection against floods. Levees have been used for many years on the European rivers and have been used to a great extent for the protection of the lands bordering the Mississippi River. At the present time there are 1,779 miles of effective levees in place between Rock Island, Illinois, and the mouth of the Mississippi. These levees contain about 400,421,000 cubic yards of material. The levee system protects about 27,628 square miles of land. At the present time the question of providing additional outlets or spillways on the lower Mississippi is being given great consideration. That the spillway will cause a temporary lowering of the flood water is beyond question, but it is not quite so certain that the ultimate effect of a spillway will be beneficial for the Mississippi, for there is a possibility that the abstraction of the water will cause shoaling of the channel below the spillway which may produce serious results in time. Levees combined with channel enlargement and spillways are being used in the flood control of the Sacramento River. The spillways, however, are of secondary

importance, the main dependence being placed upon levees and the straightening and enlarging of the channel of the river near its mouth so as to afford a freer escape of the flood waters.

In locating levees care must be exercised not to place them so near the banks of the river as to unduly crowd the stream and reduce the cross-sectional area sufficiently to prevent the escape of flood waters without causing their rise to a height such that they will overtop the levees. The great tendency is for the owners of the land on each side of the stream to crowd the levee as close to the bank of the stream as possible, leaving too little space for the escape of flood waters, with disastrous results to both sides.

Another serious tendency is the crowding of construction works such as buildings and bridge piers into the bed of the river so as to take up space necessary for the flow of flood waters. This has been the cause of many bad catastrophes in the past. In many of such cases there has been a rise of the water higher than in preceding years and it has been attributed to a greater flood; whereas, in reality, the real cause of the greater height has been due to the great constriction of the channel caused by encroachments built by man in such manner as to prevent the escape of the water.

The straightening and enlarging of a river bed will permit of the more rapid discharge of flood waters, but when this method is adopted for the upper portions of a river it simply transfers the flood problem from the upper river to the lower river. The flood control problem of any particular locality can only be solved by a comprehensive study of the entire watershed of the stream under consideration. It is rarely the case that a flood control problem is not of more than local importance, for what will help one locality is very likely to hurt another, and what is good for one place may be not at all helpful in another place.

ECONOMIC ASPECTS OF OUR TIMBER SUPPLY

By Colonel W. B. GREELEY

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ON Chesapeake Bay, just below the city of Baltimore, an enormous yard has been established for storing and distributing lumber manufactured on Puget Sound. As you watch the unloading of a steamer at this yard, jump in your mind across the continent to the sawmill where it received its cargo, follow its 6,000-mile course through the Panama Canal, and you will readily grasp

the leading factor in the lumber business of the United States at the present time and the controlling factor in its future provision of timber, namely, transportation. These lumber ships docking in Chesapeake Bay are not laden with cabinet woods or with timber of special and distinctive value. Their cargoes contain a large proportion of framing, siding, flooring, of the grades of lumber used every day in the construction of dwellings and for the more common industrial purposes. At Chesapeake Bay you may see this lumber transferred to freight cars for reshipment to points all through the Middle Atlantic states. Some of it is shipped inland as far as Cincinnati and Pittsburgh.

The factor of transportation dominates our forest situation. At the time of the Civil War, lumber manufacture was a local or at least a nearby industry in every state east of the Mississippi River. One hundred or two hundred miles marked the limit of ordinary lumber shipments from the sawmill to the market. A dollar or two a thousand feet covered the freight on the lumber of everyday use. And then with the tremendous industrial development of the 70's and 80's came the enormous sawmill, the concentration of lumber manufacture in particular regions, and its gradual movement to the west and south. With each successive outward "trek" of the sawmill, transportation has become a more important factor in the lumber business. About every twenty years, the center of lumber production has shifted to some new region still farther away from the largest centers of lumber consumption; and the freight paid on the average carload of lumber has reached a higher level. The cost of lumber transportation, either as a yearly total or on the average thousand feet, is the true barometer of the depletion of our virgin forests. Furthermore, the cost of transportation from the manufacturing region which furnishes the bulk of the lumber supply for any given market, at any given time, has to a very important degree controlled the general level of lumber prices.

To-day the big sawmilling industry of the country is dropping behind the Rocky Mountains. Washington and Oregon have become the two leading lumber-producing states. Within another decade it is doubtful if the pineries of the south will be an important factor in supplying the markets of the twenty-eight states which have become lumber importers. Eastbound lumber shipments from the west coast, by rail and by water, are increasing rapidly. Ten or fifteen years hence that region, which contains two thirds of the virgin saw-timber remaining in the United States, will apparently be our only large source of softwood lumber for the general trade. Already the cost of transportation from the

west coast is becoming a factor in the retail lumber markets of the eastern states.

The lumber movement in 1920 exceeded two million carloads, with an average haul of 485 miles. Lumber freights and charters reached a total of $275,000,000, which represents between $8 and $9 per thousand board feet on the average shipment. A large part of the lumber consumers in the United States are paying more for freight to-day than they paid thirty years ago for the commodity delivered at their doors. Many users of general construction lumber in the central and eastern states pay more for freight than this product is worth at the sawmill where it is manufactured.

It is not difficult to put in concrete terms how the rising cost of transportation has influenced the large eastern and central lumber markets. Take Chicago as an example, the greatest lumber mart in the world. Roughly, two billion feet of lumber enter Chicago every year. Thirty years ago its supply was drawn chiefly from the central and lake states, at a freight rate into the city of less than $3 on the average thousand feet. In 1921, the great bulk of Chicago's incoming lumber was manufactured in the far south or the far west, and the average freight had risen to $13 per thousand feet. In other words, rising transportation costs have taxed this lumber market $20,000,000 a year. A study of lumber shipments into New York, Pittsburgh, Detroit or any other of the large eastern consuming and distributing centers tells a similar story. Old lumber exporting states, like Pennsylvania and Michigan, now pay from fifteen to twenty million dollars yearly in freight bills on the forest products which they are compelled to import. The cost of lumber transportation has steadily become a more and more dominant factor in the principal lumber markets of the country and hence in the quantity and character of lumber consumption.

The Great Plains and the Panama Canal now separate our only large remaining source of softwood timber from four fifths of the population and nine tenths of the manufacturers in the United States. We are entering a period in the lumber business in which the transportation factor will be even more dominant than hitherto. And just as far as we can look ahead, its domination grows. When the virgin timber of the Pacific Coast is exhausted, the softwood forests of Siberia may become a controlling competitive factor in the lumber markets of America. Again the transportation cost will mount to a higher level and freight bills will weigh even more heavily in the retail price of lumber.

In other words, the amount of standing timber which we have left is much less important than its availability, as expressed by the

cost of getting it in manufactured form to some consumer who wants it. Large quantities of timber in inaccessible mountainous regions of the west will not be active in supplying our markets for forest products for a long time to come because of the excessive cost of transportation, in the log and in manufactured form combined. They are not available. Indeed, they may follow the timber of Siberia in supplying the markets of America and influencing its prices on forest products, just as our western pulpwoods are following the pulpwood resources of eastern Canada in supplying the American paper trade. In short, the volume of timber remaining in the United States, the twenty-two hundred odd billion feet of merchantable saw stuff which we estimate we still have, is not, after all, the most important factor in supplying our requirements in forest products. It is secondary to the cost of transportation, which mainly controls the retail price levels and consequently determines when the stumpage of any particular region can enter the principal lumber or paper markets.

It is not true to the mark, however, to visualize our future timber supply as readily obtainable within a constantly widening circle of transportation costs as long as the consumer is willing to pay the freight bill. The United States hitherto has enjoyed undisputed control of all the standing timber it could possibly use, with the exception of small quantities of semi-precious or other specialty woods. Foreign competition for the products of our mills has been negligible in volume and without effect upon market prices for forest products. It has been within our political power to eliminate it altogether whenever we chose. This same condition will hold true for the duration of the softwood forests of the Pacific Coast as the mainstay of the national lumber market, although it is worthy of note that oriental competition for timber from these forests bids fair to become by no means a negligible factor in volume as well as a subject of political discussion.

Once, however, we are compelled to go beyond the United States for any important percentage of our forest products, we shall encounter worldwide competition, and the story will be a different one. The pressure of population and modern civilization upon natural resources has no better illustration than the present worldwide situation as to supply and demand for coniferous timber. Mr. R. Zon's exhaustive survey of the forest resources of the world has shown that the accessible coniferous timber of the world is not adequate to meet the requirements of the twentieth century. Once we have to look beyond our own borders for forest-grown material, on a large scale, we must compete with world markets that are short of raw materials for paper and construction lumber.

International competition for forest products will certainly grow more keen as time goes on rather than less. The Forest Service has received inquiries representing Norwegian, British and Japanese capital looking to the establishment of paper mills in Alaska. The industrial growth of nations the world over has been signalized by a sustained increase in the consumption of paper and usually by a period of rapid advance in the consumption of lumber. Similar demands for forest products normally attend rising standards of living in any nation or increases in its purchasing power. The Chinese now consume about one tenth of a pound of paper per capita annually, the Russians about 6 pounds per capita, and the Japanese about 11 pounds per capita, as compared with 44 pounds in Germany, 75 pounds in England, and 149 pounds in the United States. The potential consumption of paper and lumber by the populous nations of Asia and eastern Europe, once their commercial development really gets under way, might well overwhelm the timber supply of the world within their reach.

In other words, when our own western forests are depleted to the point that we must penetrate into Asia or South America bargaining for timber, we will encounter far more than a new level of transportation costs. We will be met with stiff worldwide competition which is certain to establish price levels for lumber and paper in the consuming markets of the United States beyond anything we have hitherto experienced.

Now it is almost axiomatic that the transportation cost into any lumber market from the region which furnishes the bulk of its supply, once that cost is fairly established, is translated into higher stumpage values on locally grown timber which enters the same market. Anything that runs up the price of lumber or paper, like competition between different consuming regions, tends, if reasonably stable, to make what standing timber there is locally available worth more. The stiffer the competition New England encounters in stocking its lumber yards from the Gulf or the West Coast or from Siberia, the greater will be the price differential in favor of her own second growth stumpage.

Many elements of course influence the movement of stumpage prices. But in a broad way, underlying the general rise in stumpage values in all forest regions during the past thirty years, the effect of rising transportation costs on lumber from more and more distant sources is discernible. It is particularly striking in the case of second growth softwoods in regions accessible to large industrial centers, material which produces no specialty product and satisfies no high-grade demand but which must compete in the general market for low-grade construction or industrial uses. In new regions containing large supplies of virgin softwood tim-

ber, during any given period, the increase in stumpage values, while usually well sustained, has been relatively slow. But in almost every instance where enough second growth has been produced in old regions to become a factor in the lumber trade, its stumpage price has advanced at a much faster rate.

Extensive cutting of second-growth white pine in the New England states began about 1900. In the following twenty years the average stumpage value appears to have advanced from around $4 per thousand feet to nearly $10 in Maine and to $16 or more in Massachusetts and New Hampshire. In extreme cases second-growth New England pine has brought $25 on the stump, a price as high as that obtainable for old-growth white pine stumpage in the Lake States. A similar story may be told of the portion of the southern yellow pine region which was first extensively cut, the coastal plateau belt extending from Maryland through North Carolina. In the last ten years second-growth pine in this region has climbed in value, on an average, from about $3 to at least $7 a thousand feet. During the war its average price reached $9 and individual tracts were sold for as much as $14 a thousand.

The cost of transportation from a more distant source of timber has created these stumpage values for locally produced second growth. The same factor has accelerated the increase in stumpage values on virgin timber in each of the main forest regions of the country toward the end of its period of active exploitation. When the main source of all-purpose softwood lumber shifted from the Lake states to the southern pineries, the stumpage still left in the Lake states profited by the freight differential between that region and the new region, which rapidly dominated the old markets. The same thing is traceable in southern yellow pine to-day, with the gradual shift of the main source of our all-purpose softwood lumber to the far west.

I have purposely taken illustrations from the class of material which is consumed in the largest quantities and which consequently reflects the most general and stable basis of timber values. Illustrations far more striking could be taken from second-growth hardwoods which supply limited and specialized markets and also from wood entering into the manufacture of paper.

The broad application of the creation of higher local stumpage values equivalent to the differential in transportation costs to our future timber supply is obvious. Region by region this process leads inevitably to a point, some point, where plan-wise timber growing becomes commercially feasible and is well-nigh compelled by purely economic forces. The shifting of our principal source of softwood lumber to the west coast is setting a new price level in favor of locally grown stumpage. Lumber charters from Puget

Sound or the Columbia River through the Panama Canal to the upper Atlantic Coast seem to have settled for the present at between $15 and $18 per thousand feet. That differential in favor of competing timber grown in the northeastern states is certain to exert a powerful commercial pressure for timber culture.

Next to the transportation situation, the question of outstanding importance in relation to our future provision of timber is the amount of land that will be available for growing it and to what extent timber culture must compete with other forms of land use. Four hundred and seventy million acres of land, about one third of the soil of the United States, is now in forest, cutover land or abandoned farm land that once supported timber. The belief has been common that this acreage of actual or potential timber-growing land would be steadily whittled down by the extension of agriculture. As a matter of fact the tide of land clearing for cultivation ebbs as well as flows. The total acreage of improved farm land in the country has increased steadily from census year to census year; but in many regions it has been decreasing as a broad trend during the past four or five decades. Between the last two census years there was a net increase in farm acreage of 28,000,000 acres, but in nineteen states embraced mainly within the original forest belt east of the Mississippi River, the acreage of improved farm land decreased and in six other states it remained stationary. New England lost 32,000 farms during this period, with a net decrease of over a million acres under tillage. As a matter of fact, the increases in our national acreage of improved farm land are now coming from the regions which were never forested. Within the original forest belts of the United States, the net acreage of cultivated land is shrinking. The area of potential timber-growing land is increasing. The abandonment of more hill farms bids fair to at least offset the clearing of fertile valleys still in timber or stumps.

From what the farm economists prophesy as to the future trend of agricultural development in the United States, the abandonment of farms in timber-growing regions is apt to be accelerated rather than diminished. American agriculture is going through a terrific shaking down. Its leaders preach the gospel that success lies in concentrating farm labor and farm capital upon the most fertile and most favorably situated soils; that instead of producing our wheat crop at the rate of 13 bushels to the acre we should produce it on half as much land at the rate of 30 bushels per acre, with a corresponding increase in intensity of fertilization and cultivation. The drive for scientific farming, the use of better machinery, the putting of agriculture to a business test of profit and

loss are all tending to concentrate agriculture upon the more productive soils in the more favorable situations for access to market. The poorer and rougher and less accessible lands are going to drop out, the acres close to the profit-and-loss line will be thrown into the discard.

If this conception of the future development of American agriculture is sound, timber culture is not going to meet much competition in the use of at least one third of the land area of the United States. Other forms of land use, such as the rearing of livestock, will of course enter the competitive field to some extent. But it seems to be a reasonably safe prediction that the tendency for another generation at least will be to adjust the economic status of at least one third of our soil to timber growing as its principal crop. This will mean a gradual adjustment of the value of land of this character to the profits obtainable in growing timber. The adjustment of taxes on such land to timber growing as its principal crop will follow almost inevitably. Timber growing may indeed compete successfully for considerable areas of land that have a marginal value for farm crops just as it has done not infrequently in countries of the Old World. But the fact that we are likely to have four hundred seventy million acres, more or less, of land that will be largely without a crop unless timber culture gives it employment is an economic factor of the first importance in relation to our future supply of forest products.

There remains what doubtless is the most crucial point of all, namely, the probable demand for timber products. The United States has already passed through a cycle of rising and falling per capita consumption of lumber. From 345 board feet in 1870 it rose to 516 in 1906 and dropped to 316 in 1920. While the World War was largely responsible for the more recent and more abrupt portion of this decline and while the per capita consumption of lumber will doubtless rise when economic conditions permit satisfying the current demands for housing and industrial construction, nevertheless the drop in per capita use of lumber from the peak of 516 board feet in 1906 indicates a normal reaction arising from the higher cost of lumber and from the slowing up of new settlement and new industrial developments in their ratio to population. The reduced consumption of lumber also reflects the substitution of other materials where wood was formerly used, by reason of their lower cost or their better adaptation to construction requirements particularly in large urban centers. A large substitution of coal, oil and electric energy for fuel wood, which still forms 40 per cent. of the forest-grown material consumed in this country, has already taken place and is bound to increase.

Some of my associates who have given this matter the closest study estimate that with a present yearly consumption of twenty-two billion cubic feet of standing timber for all purposes, the substitution of other materials for wood is taking place at the rate of something less than one half billion cubic feet annually. Higher levels of lumber prices doubtless will accelerate such substitution as well as reduce the consumption of forest-grown materials where no substitutes take their place. I anticipate that when the bulk of our western coniferous forests have been put through the sawmill and the United States becomes partially dependent upon foreign sources of timber for a considerable period until new crops of wood can be grown on our own land, there will be a material and enforced drop in per capita consumption. But as long as the United States retains its dominant characteristics as an industrial nation, there is bound to be an active demand for wood in one form or another that can not long be repressed and that is bound to obtain wood by growing it at home or shipping it in from abroad within any reasonable limits of cost.

A large part of our present consumption of wood is industrial consumption, material that does not go into the primary requisites of housing and fuel but into manufactures of one sort or another. The sharp advance in the per capita use of lumber in the United States prior to 1907 reflected the tremendous increase in lumber use for manufacturing purposes, railroad building and the like fully as much as the demand for more buildings. The per capita timber requirements of the nations of Europe which are advancing industrially are increasing, not diminishing. This has been very plain in the history of Great Britain during the last seventy years. It is bound to be true of the United States where the industrial use of wood has attained a greater volume and variety than in any other nation, where new products and processes involving the use of wood have come thicker and faster than in any other part of the world, and where living standards involve a dependence upon forest products to a degree nowhere else attained, as, for example, in our consumption of paper. It seems to me a reasonable conclusion that while the per capita use of wood in the United States will doubtless decrease still further, and while our total consumption of forest products may drop sharply during the period of readjusting the source of timber supply from virgin forests to second growth, yet in the long run there can be no material reduction in the present aggregate demand for wood at a price level sufficient to make timber growing commercially feasible on the greater part of our non-agricultural lands.

The United States now consumes, including its exports, about twenty-two and one half billion cubic feet of timber annually, or

about 212 cubic feet per capita. This includes fuel wood, pulp wood, railroad ties, fencing, mine timbers, etc., as well as lumber. We have at present four hundred seventy million acres of forest land or potential forest land, a figure not apt to be greatly reduced by the extension of cultivation. In the light of European experience it seems reasonable that this land area, averaging bad acres with good, can produce under intensive forest practice the equivalent of 58 or 60 cubic feet of wood annually. That would make the yearly production for the entire country twenty-seven billion cubic feet, with a leeway of about five billion cubic feet over present consumption. Timber growing is practically without a competitor in the use of this land. Already the rising transportation costs from distant forest regions have brought portions of this land, particularly in the northeastern states, into use for growing timber under intensive methods. Every year the still rising cost of transportation, with its reactions upon public policy, tax laws, fire protection provisions, etc., will widen the acreage of land used for growing forest crops under more or less intensive methods. It is spreading over New England and the Middle Atlantic states. It is creeping down the Atlantic seaboard. It is making gains on the gulf Coast and in the Lake states. Even on the Pacific Coast, where virgin timber is still plentiful and cheap, systematic timber growing is beginning at exceptionally favorable points, like the redwood belt of California.

Forestry is not wholly a matter of cold economics. The northern races of the world were forest-bred. The forest gave them their Christmas trees, open wood fires and love of the chase. The sentiment for forest preservation and forest growing is instinctive. The forward nations of the world have been quick to recognize the public interests jeopardized by forest destruction and to safeguard them by legal principles which transcend the *laissez-faire* doctrine of political economy. And the people of the United States, who lead the world both as users of wood and as lovers of wild places, can least of all afford to view their forest problem solely as an equation of supply and demand.

Nevertheless, there must be and there is solid economic ground for timber growing, with reasonable backing in public policy, as a permanent form of land use on all fours with scientific agriculture. It is fruitless to try to put the whole puzzle together at one sitting. No one can lay out an orderly plan, according to economic formula, for shifting our source of timber from the supplies stored up in virgin forests which are sought and mined out in the order of their accessibility, like coal deposits, to successive timber crops grown in the thirty-nine states which contain large areas of forest land. Yet in a broad way this is exactly the change that is coming

about, and as far as our present experience goes, putting the consumer's money into growing trees in his own state instead of transporting lumber from sawmills 2,000 or 3,000 miles away will shift the source of supply from a temporary basis to a permanent one, without materially increasing the cost of forest products to the user and without necessitating any permanent reduction in our use of wood.

STATE POLICY IN FORESTRY

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THE practice of forestry involves the curtailment of present revenue or makes present expenditure for the sake of future return, and this return may be fifty or sixty years hence. It follows, therefore, that only those institutions which are stable and which can look ahead to the future with a certainty of existence can afford to practice forest management to the highest degree of perfection.

It is the corporate community, whether the body be called nation, state or town, that has this necessary stability. The individual citizen lives but a short time, and wishes to secure the greatest satisfaction to himself during his life. He is necessarily selfish, ready to neglect the interests of his neighbors, and still more the interests of the future citizen.

If the private land owner practices forestry he must be inspired by motives more or less altruistic. The attitude of the individual, however, as pictured above, need not be that of the lumbering or pulp-making corporations, for they should look forward to a span of life greater than that of the individual and should be interested in perpetuating their business, provided that such forest control is not wholly incompatible with the earning of a present reasonable profit on their invested capital. Furthermore, there are returns that come to a community from the practice of forestry where the revenue can not be figured in dollars and cents. These returns may be of little value to the individual woodland owner, but they are vital to the community, and, therefore, it is the community that must make the investment that will assure them.

In Europe it was the towns and small communities that started the practice of forestry, because in the seventeenth and eighteenth centuries these communities were the most stable organizations of

government. States and empires were founded and swept away with kaleidoscopic rapidity in those unsettled times, and one could not expect an established policy so necessary to proper forest administration to come from king or emperor. It was only after political chaos gave place to some degree of order and permanence that state and nation in Europe gave thought to state forests and state forest policy.

In the United States there are five agencies for the practice of forestry—the federal government, the state government, municipalities, corporations and individual landowners. It was more or less inevitable that forestry in this nation should start with the federal government, not because it was necessarily more stable than the state governments, but because it was better fitted to take the lead, and we have surrendered to it all matter of scientific research and forestry started in this country as a matter of scientific inquiry. Furthermore, it had on its hands millions of acres of public forest lands that were greatly in need of proper management and so was able to go into the forestry business extensively, with almost no expenditure of capital.

The question may arise whether the second stage of development should lie with the states, or with the towns or how far private interests can be relied upon to give us that forest management that we must have. As far as individual interest lies in the same direction as community interest, so far should individual owners be relied on. As far as the interest of the town is visible so far the town should be left to manage its own affairs, but these are matters in which the interest of the individual diverges from that of the community, or else these are matters and interests so large that the smaller community can not afford to take care of them. Then it becomes the duty of the larger aggregation, the state, to step in.

The town is permanent, yet in the average American municipality you will find the tendency to live in the present with small regard for the future. Furthermore, the rural towns that have the largest forest area are generally poor, unresponsive to new ideas and are less likely to take up a forest policy in an adequate way than those more thickly populated.

It is not our intention, however, to throw cold water on the town forest idea, but simply to show that from the economic standpoint no large results can be expected for a good many years. If, however, the sponsors for town forests realize their limitations and rely on them merely for their educational value, their possibilities for recreation and as only one more step in the program of sustained forest management, they will prove of great service.

It seems, therefore, that we must look to the state for the next significant advances in forestry. The two most essential conditions needed for the practice of forestry are a rational system of taxation and protection from fire. The first can only be provided by the state because it is the body that makes the laws for taxing real property. The second (fire protection) must either be provided by the state or by the town, or both in cooperation.

It is quite evident that the federal government with one hundred fifty million acres of national forests has a large fire protection problem of its own. I am even skeptical of the wisdom of the present system of subsidizing fire protection on the part of the federal government, for it seems to me that each state should at least take the responsibility of protecting the property of its citizens without being assisted by the national government to perform this duty. It may be justified at the present time, but as a permanent policy, I question its advisability. Massachusetts has found by experience that in all such cases of federal subsidy it pays a large part of the bill and gets but a small rebate in return. When it comes to fire protection within the state, however, the state must lead and cooperate with the municipalities, especially the smaller ones and directly and indirectly render them financial aid, for, as has already been explained, those towns that have the greatest forest area are the least able to give that area adequate protection.

I do not think that there is any opposition on the part of the residents of our cities to the expenditure of a small part of their tax money for protecting the forests in the rural towns, for they realize that the interests of the whole state are their own. It would not be easy, however, to convince them that they should contribute towards forest fire protection in Georgia or California. On the other hand, I believe that the state should not assume the whole direction and cost of fire protection, for to do so would take away the feeling of responsibility for fires on the part of the people of the towns.

We find that in spite of the feeling about home rule, many towns are only too ready to surrender it when there is an offer of financial assistance. Most of our rural towns already receive aid towards schools, libraries, roads, moth suppression, pensions, etc., and a state aid policy if carried too far may result in the creation of a lot of municipal paupers with all the faults that we ordinarily associate with the individual poor. Cooperation and aid in the direction of self-help seem to us the proper policy in fire protection, even though for the moment the results are not up to an ideal standard.

When it comes to the third great problem in American forestry, the rehabilitation of our millions of acres of logged-off idle lands, there is bound to be considerable difference of opinion as to the relative parts to be assumed by nation, state, municipality and private owner. We can safely assume that the problem is large enough to require the combined efforts of all four. The national government already has the forests that came from the public lands and has several million acres purchased under the Weeks Law fund. This policy should be continued, but it should be confined to those sections of the country where the state and private effort is manifestly inadequate to handle the situation. The available territory is large. I personally discouraged the idea of a national forest in this state because it would be difficult to get a tract of sufficient size and also because I felt that this state should of all states be able to handle its own forest problem. When it comes to the division of responsibility between state, town and private citizen for forest culture, it will be found in the end that the state and the private owner must assume most of the burden. In spite of the publicity given to the "town forest idea" no great results can be expected from it simply because those towns that are financially able to establish forests have not the available territory and those that have the land haven't the capital to invest. The state must take the lead in reclaiming waste and idle lands because by the very absorption of a portion of these lands on the part of the state the capital value of the remainder is raised to a point where the private owners of waste land can afford to invest money in its improvement.

Contrary to prevailing opinion, too low a valuation on land is not an incentive to good forest management. When forest land can be bought and is assessed for $5.00 per acre, a very meagre crop pays the interest and taxes on such a valuation. Of course one can see the other extreme where land valuation is so high that no forest crop can pay taxes and interest. Personally I believe that a basic land value of $10 per acre means better management than five-dollar land. Assuming that there are 700,000 acres of waste and idle land in Massachusetts, I think the state will need to absorb about one third of it before private effort begins seriously to take hold of the remainder.

The most optimistic believer in our state forests does not promise that they will ever provide all the forest products that Massachusetts requires. There are certain pulp and lumber companies that own large tracts of forest land. These companies do not by any means cut their entire supply of logs on their own lands. In fact, their policy is when timber is cheap to get their supplies from

the land of others and save their own, but when prices advance they cut their own timber. It would be most fortunate for the wood-using industries of Massachusetts if they were the possessors, through the state, of such a reserve supply of timber. Just how much of the forest area of Massachusetts the state should own in order to have a workable timber surplus it is difficult to estimate, but probably not less than 10 or over 20 per cent. of the forest land.

Besides providing a timber surplus account to apply towards the depreciation of our private forests as a whole, state forests offer other returns in the form of recreational opportunities. Opportunities for camping, hiking and other outdoor activities can be provided without the slightest interference with the administration of the forests from the economic standpoint, and even the protection of certain scenic features can be carried out with but slight disarrangement of utilitarian management. State forests fit in most admirably with the program of the sportsman, for they offer on the one hand opportunities for game protection and propagation, and on the other hand a place to hunt and fish without meeting the forbidding posters now so common on private lands.

With proper fire protection, an insurable fire risk, rational taxation and absorption by the state of the surplus idle land in the form of state forests, I believe that private forest owners will solve our Massachusetts forest problems. Add to this free advice as to forest management, low cost of nursery stock, free of cost to towns for municipal forests and cooperation in marketing forest products, and I believe that you have an adequate forest program for a state with the conditions that exist in Massachusetts.

In connection with this paper, I read an article by the father of American forestry, Mr. Fernow, written for our State Board of Agriculture in 1902, entitled "A forest policy in Massachusetts."[1] He summarized his recommendations as follows:

1. Improvement in forest fire laws, making them general and under state supervision and cooperation.
2. Appointment of a state forester.
3. Encouragement by financial aid of all associations and educational agencies concerned in creating an active interest in forestry.
4. Acquisition by the state for forest reserves of those stump and brush lands that by their location and condition are of importance to the welfare of the state and do not promise to private enterprise sufficient inducement to care for them.
5. Establishment of nurseries for the distribution of stock at cost.
6. Encouragement to towns to acquire forests, the state to loan towns money for the purpose.
7. Encouragement to private owners to improve their woodlands by furnishing expert advice and by providing a just tax law.

It is interesting to note that twenty years later all of these recommendations except the third, which is constitutionally prohibited, have been carried into effect, a tribute either to Mr. Fernow's ability as a prophet or to the intelligence of a state in following good advice.

THE ECONOMIC IMPORTANCE OF WILD LIFE

By Dr. E. W. NELSON

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THE conservation of wild animals and birds is not a mere fad indulged in by those who have only a sentimental interest in the subject. It has a much greater importance, due to values difficult to measure but none the less real. Wild game especially is often of direct economic value to the inhabitants of a region, not only as food but also because of the expenditures of hunters and others attracted by its presence; and the recreational and educational advantages arising from an abundance of wild life in general are incalculable.

Recent investigations reveal the fact that in the aggregate wild life resources, capitalized on the basis of a 6 per cent. annual income, represent an enormous sum, possibly exceeding $1,000,000,000, and through intelligent management are capable of a great increase.

The game and wild life of this country thus form the basis of extensive commerce in the preparation for the harvest of the annual crop, which is of great value from several points of view but mainly in supplying a highly prized form of food; as affording sport to a multitude of men and employment to others; and as a source of renewed health and vigor to numberless men attracted by it to a period of vigorous life in the open each year. The number of wild animals killed each year in the United States is not definitely known, although several states have at various times compiled statistics on the subject. The necessity for fuller information concerning the annual kill becomes of greater importance when the ever-increasing number of gunners and trappers, with their improved devices for capture and means of transportation, are taken into consideration, to the end that the capital stock may not be diminished nor the annual dividend therefrom reduced.

In 1921 there were approximately 4,500,000 licensed hunters in the United States, and the number hunting on their own lands without license was estimated at approximately 2,000,000. The returns to the various states from the sale of licenses and other

sources of income aggregate approximately $5,000,000 annually which is spent mainly in the work of guarding, propagating and maintaining the breeding stock and increase of wild life for future seasons. Every state of the union except North Carolina, Florida, Mississippi and Nevada has a special agency charged with the duty of looking after the wild life resources of the commonwealth, and wardens are constantly employed in the statewide work of staying the transgressor of the conservation laws, and in feeding and otherwise conserving the wild life.

The decrease of wild life with the advance of settlement and occupation of the land by man and his domestic flocks and herds was inevitable. It is a blot on our custodianship of the wild life of the country, however, that commercial slaughter should have been permitted to the extent that the supply was ruthlessly wasted, both as regards large and small game and game birds. The classic example of big game destruction is furnished in the case of the buffalo, which roamed in countless numbers in the days of the aborigines. In the case of game birds, the myriads of passenger pigeons brought to absolute extinction by the pot hunter also furnish a striking example. Civilized man and his inventions have become a menace to wild life throughout the world.

The wild game and fur bearers of the land had a wonderful part in the upbuilding of this country from the arrival of the earliest colonists through the era of exploration and settlement, through the period of construction of the transcontinental railways and even to-day is vital to the existence of miners and others in remote parts of Canada and Alaska.

The Buffalo

After the construction of the first transcontinental railroad, commercial companies were organized to gather the bones of the buffalo slaughtered in part for the subsistence of the great construction gangs employed in its building. Some idea of the magnitude of the operation may be gathered from the reports of a single railroad—the Atchison, Topeka and Santa Fe.

The traffic in bones and buffalo products from the Great Plains region are recorded by Dr. Hornaday in his report published in 1887 on the extermination of the American bison. There appears to be good ground for the belief that the statistics furnished by this one railroad represent only one third of the entire buffalo product. It is therefore in order to base further calculations upon these figures. According to evidence gathered on the spot during the period of the great slaughter, one hide sent to market in 1872 represented three dead buffalo; in 1873 it represented two; and in 1874 one hundred skins delivered represented 125 dead animals.

The total slaughter of buffalo by white men in three years, 1872-74, may be approximated on the foregoing basis, with a knowledge of animals actually marketed. Railroads reported shipments of 1,378,359 hides; this would mean an additional 1,780,461 animals killed and wasted, or a total slaughter of 3,158,730. The rapid extermination is shown by the fact that approximately 3,000,000 of these animals were about evenly divided between the first two years, while in the third year there were only 158,583 so slaughtered. The Atchison, Topeka and Santa Fe Railroad also reported that during the same three years 2,250,400 pounds of buffalo meat and 10,793,350 pounds of bones of these big animals were shipped over its lines.

After the great slaughter of 1880-84 the buffalo was practically exterminated as a wild species. A census of buffalo taken in 1889 showed only 1,091 animals wild and in captivity in the United States and Canada.

Game Birds

With the extermination of the buffalo began the development of the great markets for quail, grouse and wildfowl in Chicago, New York, St. Louis, Boston, Philadelphia, Baltimore, Washington and other large cities, at first sanctioned by law and later supplied in defiance of the laws of the states from which supplies were drawn. The passage of the federal Lacey Act, in 1900, prohibiting interstate commerce in game killed in violation of the state law, aided materially in staying illegal traffic in game. With the prohibition of sale of migratory game birds under the Migratory Bird Treaty Act of 1918, game, except rabbits and squirrels and venison in a few places, has practically been taken off of the market. The fact that game is not now generally commercialized, however, does not depreciate the individual value of the game killed, although the total kill is greatly lessened, the channels of consumption having been diverted from the patrons of hotels and restaurants to the hunters and their friends.

Sportsmen who in many sections are enjoying good wildfowl shooting to-day now realize the conditions they would be facing were it not for the beneficial effects of federal laws giving protection to migratory birds. Federal prohibition of the sale of migratory game birds crowned with success the campaign led by conservationists of vision whose goal was to limit the killing of game to the field of recreation and sport. With the abolition of spring shooting, wildfowl conditions are again approaching those of two or three decades ago.

Other Big Game

Recent estimates of the total number of big game in the United States, other than deer, in 1920 are as follows: Buffalo, 3,400; elk, 52,000; antelope, 7,500; moose, 7,000; mountain goats, 6,000; mountain sheep, 10,000. This total of about 86,000 covers only the big game south of the northern boundary of continental United States, and does not include the game of Alaska or of any part of Canada.

It is of course impossible to estimate accurately the value of this big game. Some of the elk, moose and sheep belong to species found nowhere else in the world and are now represented by small herds. Unlike most things which have a definite value, wild game can not always be replaced when it is exterminated over an area. No market value in the ordinary sense of the word can be placed upon such animals. If buffalo should be valued at $200, antelope and moose at $100, elk at $75, and sheep and goats at $30 each (all conservative figures, at least for animals for propagating purposes), the total value of the big game, other than deer, would be not less than $5,000,000. Deer are much more abundant than any of the other kinds of big game, and with the figures available it is probably safe to estimate that their value is at least twice that of other big game, making a total value of at least $15,000,000 for all the big game in the United States, exclusive of Alaska.

Elk

Preservation of the elk in the Yellowstone Park and other regions will not only maintain a fine example of the great game herds which once frequented the west, but at the same time will perpetuate big game hunting on a considerable scale.

It is believed that these elk herds will prove such an asset to the states of Montana and Wyoming, where they will far exceed in value the returns from the livestock which would replace them if they were to be eliminated from the range.

Game Estimates

In any attempt to approximate the total value of the game killed annually in the United States, it is to be constantly borne in mind that statistics of the actual kill are not available for any considerable portion of the country. A few states have fairly accurate estimates of the number of deer and other big game killed over a considerable period, while in others the returns by licensed hunters form the basis of a fairly satisfactory estimate. Among the schemes for collecting data on the annual kill of wild life are those requiring reports by hunters, trappers or wardens, or those involving questionnaires to representative sportsmen in the differ-

ent localities of a state. Given a fairly accurate estimate of the kill, it becomes an easy matter to calculate the value of the game. A few only of the estimates available can be given owing to lack of time.

The state game and fish commissioner of Minnesota, in a paper read before the Tri-State Development Congress at Milwaukee, estimated the number of deer killed in the three states of Michigan, Minnesota and Wisconsin as follows: In 1919, 68,286; in 1920, 48,072; and in 1921, 37,500; or a total of 153,858 in the three seasons. At $30 each, the food value of the deer killed amounts to $4,415,740.

The total number of deer killed in 12 years in New Jersey, beginning with 86 in 1909 and ending with 844 in 1920, is 3,626; and in Massachusetts the number killed from 1910 to and including 1920 is 13,081.

Sixty years ago deer were practically exterminated in Vermont, and a few sportsmen in Rutland county secured 17 for restocking the county. After a closed season for a number of years the season was open on buck deer only in 1897, and in that year 103 were killed. A total of 4,440 deer were killed in the state in 1920 and from 1897 to 1920, inclusive, the total number, according to the records of the state game department, reached 44,286.

The value of the wild life kill in Michigan for 1920, including $3,000,000 for fur-bearing animals, was placed at $4,975,377; in Wisconsin, for 1921, including game birds at $2,333,000 and fur-bearing animals at $1,341,000, the total is $4,440,000; and in Minnesota for 1921, including 1,761,062 game birds and 631,140 fur animals, the total value of wild life killed is placed at $4,690,262. In 1920, the value of the game alone, including among other species 18,572 deer, 501,525 ruffed grouse and 1,414,889 wild ducks, was placed at more than $2,600,000.

In commenting on the statistics of game killed in Michigan, Minnesota and Wisconsin the Minnesota commissioner stated "it should be borne in mind that the figures represent merely the annual income from the permanent capital stock. Figured at 6 per cent. income, the capital investment on which we are collecting this annual dividend would amount to over $235,000,000 in the three states."

The game killed in New York in 1918, including 8,293 deer, 465,590 cottontail rabbits, 641,508 fur animals and nearly 250,000 game birds was valued at $3,239,277 by the conservation commission.

The total weight of the game killed in Pennsylvania was figured at 7,252,048 pounds in 1919, and in 1921 9,497,277 pounds. The game commission placed the value of the meat supply from the

1921 kill of game, on a basis of current food prices, at $3,500,000, and valued the furs taken in the state at $2,500,000, making the total annual value of the kill of wild life in the state $6,000,000.

Fur Resources

The fur trade, which was the forerunner of agricultural and other industrial developments, has now become one of the large and important industries in the business world, providing employment for thousands of skilled and unskilled workers and contributing to the comfort of people who wear fur garments. North America has been the leading continent in the natural production of furs and is also the greatest fur-consuming region in the world. Imports of undressed furs into the United States during 1920 were valued at over $84,400,000, and of dressed furs and manufactures thereof aggregated $9,131,000. Members of the national organization of fur dressers and dyers dressed during 1920 furs valued at $52,910,589. The revenue derived by the federal government from the 10 per cent. excise tax on articles made of fur amounted to $15,311,214 in 1920. Exports of furs and manufactures thereof for this period were valued at $32,889,995. The approximate turnover in the fur industry of the United States during 1920 was $352,000,000.

Judging from reports and observations in the field, it is estimated that 500 ranchers are raising silver foxes in the United States, that they have more than 15,000 foxes in captivity, and that the value of the investment is about $8,500,000.

Alaskan Fur Resources

Through the cooperation of postmasters and commercial transportation companies in Alaska, shipments of furs by mail, express and freight are reported to the Biological Survey, which has jurisdiction over Alaskan land fur-bearing animals. It is estimated that the value of these furs will in ordinarily good years exceed one million dollars.

Fur Seals

In the report of the Bureau of Fisheries for 1909, the commissioner made the following statement (p. 29):

> If pelagic sealing could have been stopped in 1897, the seal herd of to-day would contain 300,000 breeding cows (as against 50,000, the number for the season of 1909), and the product of the hauling grounds would have risen to 50,000 skins, yielding a government revenue of $500,000, as against less than 15,000 skins and a government revenue of $143,000 for the present year. Without the drain of pelagic sealing the herd would continue to increase almost indefinitely.
>
> The Alaskan fur seals constitute the most valuable fishery resource that any government in the world ever possessed. It is little less than a national

disgrace that the herd of four to six million seals which came into our possession when Alaska was acquired from Russia and has been under our charge ever since should have been allowed to dwindle until to-day it numbers less than 150,000 of all ages. The mildest way in which to characterize the dissipation of this great resource of wealth of our people and of revenue to our government is that it is a serious indictment of our business capacity. The extent of our loss may be partially seen when it is stated that the failure to maintain the seal herd has during the last thirteen years resulted in a net loss of revenue of not less than $1,600,000, has permitted nearly 300,000 fur seals having a market value of over $5,700,000 to be appropriated by aliens, and has encouraged those nefarious pelagic operations by which additional fur seals having a value of at least $5,000,000 have been killed at sea, but not recovered; while through the slaughter of breeding females their pups—on the islands, unborn and prospective—with a potential value of fully $20,000,000 have been sacrificed and wasted.

Records of pelagic sealing carried on in Alaska under contract from 1870 to 1899 show 1,840,364 seal skins taken, from which the government derived a gross revenue of $6,010,565 and a net amount of $5,807,910, or an average of $3.15 per skin. Contract sealing was continued from 1890 to 1909, during which time 339,180 skins were taken, from which the government received a gross revenue of $3,752,415, netting $3,156,330, or an average of $9.30 a skin.

In carrying out the provisions of the seal fisheries convention between the United States, Great Britain, Japan and Russia, signed on July 7, 1911, the seal herd has been under the direct management of the Department of Commerce. From 1910 to July 1, 1921, notwithstanding a closed season of five years, which expired August 24, 1917, 101,594 skins were taken and marketed for a gross sum of $4,321,141.03, and a net amount of $3,169,544.53, or an average of $31.20. Of the net amount, however, $1,010,869.24 has been paid to Great Britain and Japan under the terms of the convention, and 41,091 seal skins remained on hand to be sold.

At the time the Pribilof Islands were first leased the herd was estimated to contain over 2,000,000 animals, but during the leasing period of 40 years it was depleted to 132,279 animals. From 1910 to 1921 the herd is reported to have increased to 581,453.

The following states have at one time or another placed a money value on their annual kill of wild life: Idaho, $1,000,000; Michigan, $4,975,377; Minnesota, $4,690,262; New York, $3,239,277; Oregon, $900,000; Pennsylvania, $6,000,000; Vermont, $502,000; and Wisconsin, $4,440,000, or a total of $25,746,916, in the eight states mentioned. Capitalized at 6 per cent. interest, this would indicate an annual dividend on approximately $430,000,000. Granted that a third of the wild life of the United States is found in the eight states mentioned, the estimate of $1,000,000,000 for the United States is conservative.

THE ECONOMIC VALUE OF PUBLIC PARKS AND SCENIC PRESERVATION

By Dr. GEORGE F. KUNZ

PRESIDENT OF THE AMERICAN SCENIC AND HISTORIC PRESERVATION SOCIETY

PUBLIC parks and reservations—municipal, state and national—have several values, esthetic, educational, hygienic (which includes recreative) and economic. These values are so closely related and interdependent that it is difficult to separate them and to say where one ends and the other begins, for as a matter of fact it is the esthetic and the educational and the hygienic values that give them their economic value.

It is a mistaken notion that only the comparatively few cultured and highly educated people have esthetic appreciation of parks, reservations and places of natural beauty. Esthetic appreciation is a natural instinct and a very democratic possession. Where it does not exist it has been crushed out or suppressed by adverse circumstances. Children would rather play on the grass than on the pavement. They prefer a tree to a lamp-post or telegraph pole in their games. They instinctively pluck flowers if they can when they see them. They do not hesitate to stop passers-by who are returning from the country with wild flowers and beg a few blossoms. In everyone, from the child of the east side who plucks the flower in Central Park up to the mature and cultured traveler who revels in the glories of the Yellowstone, the Yosemite, or the Grand Canyon, the esthetic instinct exists as a natural craving that calls for satisfaction; and its satisfaction is one of the sources of the highest happiness.

Whatever gives happiness has value, although that value can not always be expressed in terms of dollars and cents; and yet frequently it can. In a residential district, a house and lot situated amidst neighbors who have unkempt and untidy dooryards and backyards is not as valuable in dollars and cents as one surrounded by neighbors who have attractive dooryards and backyards. Barren dirt house lots, with heaps of rubbish of all kinds, are a poor asset to the owner and neighbors; whereas grassy lawns, trees, shrubs, gardens and general tidiness are an actual economic asset to the whole neighborhood. Sometimes a single beautiful tree, or a single great rock, will make a place famous and add to its value. The same argument applies to public streets and public parks. A tree-lined roadway or a public park is a public asset, and by a public asset we mean an asset of the individual people

who compose the public. It enhances their pleasure and comfort and it enhances the value of the neighboring property.

The same is true of almost any natural feature within a town or its neighborhood. No matter how level and seemingly unpicturesque the region may be, there are almost always gullies or ravines, protected from the wind, in the bottom of which the flora and vegetation are more prolific than on the wind-swept upper levels. These gullies or ravines are often used injudiciously by the neighboring inhabitants as dumping places for garbage and refuse material. If, instead, the inhabitants would bury or otherwise dispose of their refuse, and keep the ravines clean and attractive, they would be transformed into parks and form an asset instead of a detriment to the community. An interesting illustration of the value of preserving glen scenery within a town is afforded by the Cascadilla Glen in Ithaca, New York. This beautiful ravine runs along the southern boundary of the Cornell University Campus. A few years ago the Cascadilla Company, including one of the public-spirited trustees of the American Scenic and Historic Preservation Society, Hon. Robert H. Treman, acquired an old mill and considerable property along the ravine, removed the mill, beautified the property, and conveyed to Cornell University all their rights in Cascadilla stream down to a certain bridge. A few weeks ago Mr. and Mrs. Treman conveyed to the university some lots near the bridge, permitting the removal of some houses and the opening up of a beautiful vista up the ravine and toward the campus. Such gifts and acts are fine examples of civic spirit: and they confer a lasting benefit on the community.

We may cite as an illustration of the economic value of a private park Gramercy Park in New York City. In 1831 Samuel B. Ruggles acquired from James Duane a farm of twenty-seven acres, including the present Gramercy Park and surrounding property. This farm comprised an area equal to about 108 city lots. Ruggles converted 42 lots into a private park and sold the 66 surrounding lots with certain restrictions and with the privilege of the use of the park. It was a wise piece of business, for the esthetic and hygienic value of the park of 42 lots enhanced the economic value of the surrounding 66 lots more than 100 per cent.

As an illustration of the economic value of a great city park we may cite Central Park. The great municipal park contains 843 acres. Back in 1838, when land was bought for the old Croton Reservoir, it cost about $2,316 an acre. Eighteen years later, in 1856, land for the park cost about $6,838, an increase in value of about 300 per cent. In 1863, the last purchase for the park cost about $18,147 an acre, an increase of 780 per cent. in 25 years.

The land for the whole park cost $7,389,727, and is carried on the books of the Tax Department as now worth $225,000,000, an increase over thirty fold (3,000 per cent.) in value. The foregoing figures refer to the land value of Central Park itself. The increase in the value of the surrounding property has been more than twice that rate. In 1856 the valuation of the real estate in the twelfth, nineteenth and twenty-second wards—all of Manhattan Island north of 40th Street—upon which there were comparatively few improvements, was $25,671,490. Ten years ago, the valuation of the same land without improvements was $1,941,787,550, while the valuation of the land and buildings was $2,888,306,240. The increase in the land value alone of the surrounding property, due largely to the presence of Central Park, was over seventy-five fold (more than 7,500 per cent.).

Let us now take some illustrations of great state reservations. The state owns in the Adirondack and Catskill forest preserves 1,992,516 acres of land. For the purchase of this domain the state has expended about $10,000,000. This figure includes $4,075,000 appropriated before the bond issue authorized in 1916, and about $6,000,000 thus far expended or contracted for under the bond issue. Six years ago, when only about $4,000,000 had been expended for land purchase, the area acquired was conservatively valued at $40,000,000. By a like ratio, the present forest preserve is worth about $100,000,000, or tenfold its purchase price. But that is not the sole measure of the economic value of the forest preserve. Its function in conserving the water supply is of inestimable value to the industries deriving water-power from the Hudson and its tributaries, and eventually it will be a source of wood for industrial use. The railroads, hotels and local interests also derive large revenues from the hundreds of thousands of visitors who seek the Adirondacks for health and recreation. Up to a few years ago the New York Central Railroad Company used to publish statistics of its excursion business due to the Adirondacks. These figures are not now available, but if known they would represent a very large figure.

Niagara Falls is a purely esthetic reservation of about 412 acres of land and water. The state paid $2,500,000 for it. It was not bought for any material purpose. It was acquired so that the people of the state and the nation, and of the whole world, might have free access to one of the sublimest spectacles of nature. The state itself derives no income from it, but the railroads, hotels and local interests find it of great economic value. It has been estimated that not less than 1,250,000 persons visit Niagara Falls each year, and it was formerly considered conservative to estimate that

each visitor spent about $20 on fares, hotel accommodations and other local expenditures. On that basis, the revenue on account of the scenic beauty of Niagara Falls could be reckoned at about $25,000,000 a year. At present rates, probably $30,000,000 or $40,000,000 is spent annually to witness the spectacle of Niagara.

The number of visitors to the Palisades Interstate Park exceeds that of the visitors to Niagara Falls, being estimated at 1,782,643 last year. This large number is due, of course, to the park's proximity to the enormous population of the metropolitan district. On account of that proximity and the relatively small expense of access to the park, the "economic value" of the park may not be as great as that of Niagara. But this illustrates anew how misleading it is to attempt to estimate the benefit of public parks by their "economic value." The economic value of the Palisades Interstate Park is represented, not by what people spend there and in going there, but by what is saved them on account of the inexpensiveness of the trip and by what they gain from going there. And here again we must emphasize the fact that the greatest value of these parks can not be computed in dollars. The recreation, the physical and mental refreshment which people get from the trip and the visit is their greatest revenue.

This is true proportionately of the six important state properties which the American Scenic and Historic Preservation Society administers—Philipse Manor Hall, Stony Point Battlefield, John Boyd Thacher Park, Fort Brewerton Reservation, Battle Island Park and Letchworth Park—to which there were probably 100,000 visitors during the year.

The movement for state parks has received a great impetus during the past two years from the two national conferences on state parks, the first held in Des Moines in January, 1921, and the second in Bear Mountain Park and New York City in May, 1922. The American Scenic and Historic Preservation Society has done a great work during the preceding 25 years in disseminating information on this subject throughout the country and in lending encouragement to the creation of public reservations in other states; and yet nearly half of the states have no state parks and many other states had only the beginning of a state park system. The national conference was therefore called for this intimate exchange of information and ideas and for the encouragement of the backward states in this important movement. The new state parks created during the past two years have largely been due to this national conference.

With reference to the creation of municipal, state and national parks, it should be noted in passing that except in desert regions,

scenery can not be preserved as natural scenery without trees, birds and other animals. Trees are the natural ornaments and protectors of the land; and birds and four-footed animals are the natural inhabitants of the woods. These are parts of a perfect scenery. If the trees along the roadsides and in the fields are preserved, the birds will come to them, and if the trees are thick enough and wild life is protected, the wild animals will seek their refuges there. These are all elements of scenic and educational value as well as economic value.

As to our great system of national parks, we gather some interesting figures from the reports of the National Park Service. In the fiscal year of 1921 there were 1,171,797 visitors to the national parks and monuments. The government spent about fifty-four cents per visitor for maintenance and administration—"about the cost of a good seat at a movie show," as the director of the National Park Service expresses it. Mr. Mather considers it very conservative to estimate that each visitor spends at least $100 on his tour. On that basis, the national parks represent a business of $117,179,700. And it should be added that the systematic development of our national parks is very young and their patronage in its infancy. A New York financial newspaper in 1915 estimated that the American tourist travel to Europe cost this country $500,000,000 a year. The more we cultivate the spirit of "seeing America first" and appreciating our own privileges, the greater will be the economic value of our public reservations.

The older European countries have long appreciated the value of preserving their natural and their historic monuments, and this work is carried on by such organizations as the National Trust in England; the Commission des Monuments Historiques in France; the Bond Heemschut in the Netherlands; the Staatliche Stelle fur Naturdenkmalpflege in Germany; and the Swiss Nature-Protection Commission in Switzerland. Within a few years, partly through the encouragement of the society of which I am president, the Society for Preserving Landscapes and Historic and Natural Monuments has been formed in Japan and a national law has been passed for the preservation of historic landmarks and places of exceptional scientific or scenic interest. Canada also has recently formed a landscape society, and the National Park Service of Canada has derived much encouragement and assistance from our society.

The American Scenic and Historic Preservation Society, in the course of its work during the past twenty-seven years, has published twenty-seven annual reports, comprising 10,350 pages of reading matter and 916 pages of illustrations, dealing with 39,634

names and subjects. The indexes of the last twelve reports contain 65,692 page references. These have been circulated all over the United States and Europe with valuable results.

The total known gifts of land, moneys, etc., by members of the society for public parks, civic improvements and historic preservation up to January 1, 1922, amounted to $6,181,419, and doubtless there have been many more of which we have no record.

The amount of gift funds expended by the society itself exclusively on public properties prior to January 1, 1922, was $57,256; the amount of gift funds expended by donors directly with the advice and cooperation of the society, but not passing through the society's treasury, $83,125; and the amount of state funds expended by the society exclusively on state properties without administrative charges, $282,819.

The society has been directly instrumental in the creation of eight state parks and one city park; partly instrumental in the creation of four other state parks including the Palisades Interstate Park; and indirectly helpful in the creation of still others.

These figures indicate the strength of the movement for scenic and historic preservation and also what one organization can do in promoting it.

There have been a number of instances where scenic preservation or beautifying has brought great financial return. One of the most notable of these instances is that of the Cathedral at Copenhagen. This cathedral was built in the outskirts of the city and was left in an unfinished condition for over a century, with the result that nothing but shanties and hovels surrounded it. Finally, a wealthy citizen of Copenhagen volunteered to complete the edifice at his own expense, provided he were given authority to proceed. The authority was given, he completed the cathedral, and not only paid for its completion, but incidentally cleared a considerable sum of money above the cost of the work, because he had immediately bought all the land in the vicinity of the cathedral, made a beautiful select section of it, and sold it for the finest residential property.

Another instance is that of the Buttes Chaumont in Paris. This chalk mountain was in the outskirts of Paris and was filled with pits and holes and was the abode of the most questionable characters during the French Commune. Gradually lakes were formed where there were holes, and the hillsides were set with trees, with the result that a splendid residential section now surrounds this formerly forbidding and dangerous region.

By the selection of important points that are frequently denuded and bare, and planting them with trees and bushes, a few

acres will frequently influence many hundreds of acres in creating a proper environment.

If, when the plans for the city of New York above 10th Street were being prepared, there had been a landscape architect, or someone with judgment, he could have used the various ponds for small lakes, he would not have eradicated every hill, but would here and there have given us a small park, and would not have laid out the city on the lines of a checker-board, with a loss of both beauty and accessibility, and instead of giving us few avenues and many streets, he would have reversed the order and given us many avenues and fewer streets, with the result that traffic would not have been rendered difficult for many years and almost impossible as it is today; moreover, as the sun rises in the east and sets in the west, it would have meant that two or three times as many homes as now would have had sunlight all day, whereas at the present time in many of the side streets the sun is never seen and the streets are filled with ice, and the death rate of the entire city has been notably increased by the little knowledge shown of what New York was to be in the future.

The setting aside of the area occupied by Central Park, 900 acres, at a cost of $40,000,000 has been a most profitable investment. One side, the east side of the park, is worth more than the cost of the park and the cost of the east side of First avenue, plus $1,700,000 or more. And the three other sides nearly double this accretion of value and we still have our Central Park.

ECONOMIC ASPECTS OF OUR NATIONAL PARKS POLICY

By ROBERT S. YARD

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SHALL we keep our national parks or shall we turn them into national forests?

For three years two organized bodies of Americans have been disputing before the court of Congress precisely that question.

One side seeks to destroy, the other to preserve, the complete conservation which, alone, from the beginning, has differentiated our national parks system from all other public reserves. It was Yellowstone, the first national park, that half a century ago defined the primary use of the great system which was to follow.

This primary use may be described sufficiently for present purposes by calling a national park a museum. Our national parks

system is a national museum. Its purpose is to preserve forever, "for the use and enjoyment of the people," certain areas of extraordinary scenic magnificence in a condition of primitive nature. Its recreational value is also very great, but recreation is not distinctive of this system. Our national reservations are also recreational. Our national forest, set apart for scientific commercial utilization, is very highly recreational. The function which alone distinguishes the national parks system from the national forest is the museum function made possible only by the parks' complete conservation.

The law has never clearly defined a national park. If it had, there would be no war to-day between the politically and financially powerful few who seek to break down the system's conservation, and the increasing millions who earnestly contend that the public policy of half a century shall not be destroyed for the profit of some local industrial interest, or of such interests in combination.

The law of 1916 creating the national park service defined its purpose "to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them (the parks) unimpaired for the enjoyment of future generations." Neither this nor other laws specify in set terms that the conservation of these parks shall be complete conservation, though this is the clear inference from the law quoted considered together with the organic laws of the individual parks from the beginning. The people's defense rests upon this inference and upon the public policy flowing from it. Complete conservation was intended by Congress and the nation as the particular purpose of the creation of the first national park of the system, Yellowstone. Its presumption took practical shape as soon as the Congress which created Yellowstone assigned it to the Interior Department for administration in March, 1872. Every Congress and every administration since has confirmed it, thus creating the national policy.

Those business interests which have labored so hard and so long, at so great an expense of time and money, to break down the protecting wall of complete conservation hold that the national parks have no economic value until their stores of water are producing cash revenues. They ignore the public policy of conservation, shouting that "eastern sentimentalism" alone is in opposition to their program of industrial invasion. By inference they assert that sentiment has no economic value.

But even these acquisitive gentlemen, I think, would freely admit that anything that makes strongly for the physical and mental health of the people, for pride of country, for the sanity of big horizons, for better comprehension of the needs and viewpoints of

distant sections of the country, for outdoor living, for travel, recreation and recuperation, makes powerfully for individual and national fitness to carry on and up the nation's material progress. All the money the nation possesses in public and private ownership could not purchase influences to accomplish such results if none existed, and surely no materialist has the temerity to deny them economic value beyond the possibility of price.

There is one element in the popular conception of our national parks system which I want especially to emphasize. That is its importance as a formal visible expression of the greatness and glory of this nation among the nations. Much of its value flows directly from this conception. The sentiment which brings the majority of the people so promptly to the defense of the system endangered is very far removed, indeed, from "sentimentality," unless national pride can be so termed. Were these parks in private or state ownership, or even in national possession but not set apart as a protected national institution, they would arouse nation-wide individual admiration, but they would not inspire a national enthusiasm.

In these enlightened days nature conservation is an American creed, but in no sense is it a fighting slogan. Defeating the spoilsman aroused the nation two or three decades ago as few reform movements have done, and we are still alert to crush public greed disguised as business. But neither of these causes, nor both combined, can in the least explain the eagerness and indignation with which the people in every state now rise at the mere word of warning in defense of their national parks system.

To one observing the popular state of mind from the center of this movement of defense, its essence is as clear as white light. There is no possibility of mistake. Two years ago the unannounced reading of national parks defense resolutions at the convention of the Daughters of the American Revolution brought instantly to their feet two thousand delegates representative of all the states. Even a labor convention in Chicago, plumbers, by the way, passed park defense resolutions and forwarded them to Congress. The defeat of the Walsh bill to dam Yellowstone Lake was not a defense of Yellowstone, but of the national parks system. These people are not fooled in the least by special pleadings. Piteous appeals for just one little reservoir in an obscure corner of one national park are unerringly understood to call for the building of many reservoirs in all the parks. The greatest protest, yet, that against Secretary Fall's proposed All Year park, is inspired by the certain knowledge that its many commercial precedents, if introduced into the system, will promptly infect all.

Why this intensity of protest? And why do millions join it who have never seen a national park and expect never to see one?

Simply because our national parks system has come definitely to mean to the people what, in kind at least, our flag means, namely, the majesty and pride of the nation. It is something extraordinary, inspiring, greater in quality and variety than the similar possessions of any other nation—and it is tangible, visible to all the world. Finally, it is idealistic in high degree, the concrete visible expression of a quality of mind and spirit which Americans believe that they possess in higher degree than any other people.

The American people insist upon their idealism. The fact that half a century of Congresses and governments, without any urging of the people until now, has safeguarded this system from all assaults upon its integrity restores their oft-shaken belief in our nation's essential righteousness and confirms the national faith in the form of representative government. This conclusion is no refinement of inference. It shines clearly in the expressions, crude or complete, which come increasingly to me from the plain people of all parts of our land.

To this audience there is no need of driving the argument home. The subject assigned me is "Our national parks policy in its economic aspects." It needs no elaboration to show that it is not the areas called national parks, majestic though many of them are, that mean this inestimable thing to the people, but the vitally significant creation which our national policy has built out of them. Completely conserved, with all that this implies, our national parks system is one of the inspirations to that pride of country and belief in its nobility which are essential to a nation's greatness and power. Its economic usefulness, therefore, is beyond computation.

Another economic value which our national parks possess in very high degree because of their conspicuousness and the eagerness with which they are studied both in the parks themselves and at home follows from their ability to convey scientific facts palatably to large masses of people. They are not only a national museum system. Their practical educational values are extremely high.

The parks in the system are nineteen in number, seventeen of which are within the United States, one in Alaska and one in the Hawaiian Islands. There are also twenty-six national monuments preserving objects or areas of archeological or special scientific value.

Of the seventeen national parks within the United States, fifteen are in the far west, one in the south, and one in the far east. Two are desert parks, three moderate altitude parks, and nine in the high mountains.

More specifically, three of these national parks, Grand Canyon, Zion and Glacier, illustrate the land forms produced by erosion

acting upon sedimentary rocks; four, Yellowstone, Mount Rainier, Crater Lake and Lassen Volcanic, show different phases of volcanism; three, Yosemite, Rocky Mountain and Lafayette, exhibit eroded granite; two, Sequoia and General Grant, preserve extraordinary forests; and one, Mesa Verde, preserves the most remarkable of our prehistoric ruins.

Again, seen in different classification, the parks illustrate the geologic sequence of America's making. From the Granite Gorge of the Grand Canyon to the top of the Pink Cliff in Bryce Canyon are displayed the colorful strata representing perhaps a hundred million years of world building, a library in brilliant bindings of the dramatic creation of our southwest. The volumes missing there may be found in Glacier.

Our granite parks illustrate the tremendous processes of the upbuilding of gigantic mountain systems, their destruction by erosion, and their rebuilding. The everlasting struggle between the uplifting forces from below and the wearing-down forces from above are illustrated in minutest detail. In Mount Rainier, we see full-bodied glaciers; in Yosemite and Glacier and Rocky Mountain we see the small remainders of once-mighty glaciers, and camp out in deep channels whose like are now making at Mount Rainier.

Our volcanic parks likewise tell their dramatic tales of tempestuous mountain building, of the blowing up and collapse of huge cones, of the creation of rolling plateaus, of hot springs and geysers as stages in dying volcanism. Lassen is a living volcano. Dead volcanoes are found in several parks.

Every national park makes its own different contribution to the great story, and in combination they tell us the whole minutely, dramatically, fascinatingly. Even the low granite knobs of Lafayette, emerging from inlets, add their chapter on the subsidence of the Atlantic Coast and the sea's invasion of valleys scooped by glaciers then fifteen thousand feet above the tide.

The processes which wrought America are seen in our parks in full operation to-day. Best of all, the popular lessons learned in these thrilling national museums have their application in every square mile elsewhere. The whole world becomes a new and eloquent and fascinating thing.

In all of them wild life conditions remain untouched. Except to make way for roads, trails, hotels and camps sufficient to permit the people to live there awhile and contemplate the unaltered works of nature, no tree, shrub or wild flower is cut, no stream or lake shore is disturbed, no bird or animal is destroyed. These parks are literally national museums of the original American wilderness.

In most of them wild animal life is restoring itself very slowly

from the generation of the great slaughter, when this land of most exuberant wild creature life was denuded in extravagant ruthlessness. But there are two parks, Yellowstone and Glacier, which were so remote then that they measurably escaped, and these to-day are fair examples, perhaps, of the animal population of the original wilderness; and another, Mount McKinley, in Alaska, which will preserve its immense herds of caribou and mountain sheep nearly intact, provided Congress is not niggardly in guardianship.

The educational value of our national parks is evident. If you question the opportunity, go to the parks and ask its visitors. Or stand on the rim of the Grand Canyon, or in one of the great forests of Yosemite, or on the shore of Iceberg Lake in Glacier—anywhere in any national park—and offer explanations aloud. Instantly you will become the center of an eager questioning crowd. With few exceptions those who visit our national parks want earnestly to know.

Wanting to know is one of the striking characteristics of the American people. The popular museums and school-rooms which constitute our national parks system, with their millions of waiting students, are not yet utilized. The system may be compared to a school equipped with every educational device, filled with eager pupils and with no teachers. I call the attention of this great scientific association to an incalculably valuable economic function of our national parks system almost wholly unused. The association which I represent was organized to promote the utilization of this opportunity among those professionally equipped to carry it through. That we have accomplished little toward this end is because, almost upon organization, we were called to the defense of the system's very existence against powerful attacks suddenly concentrated upon it. While we hold this opportunity safe, we invite you to avail yourselves of it.

Still another important economic function of our system of conserved parks may be illustrated by observing carefully the men and women who visit them. They include nearly every kind of American.

Every summer we meet a few of the distinguished and the conspicuous in the national parks. Politicians, merchants, legislators, artists, architects, bankers, judges, millionaires and the merely fashionable all are represented. But we meet in immense numbers business and professional men and their families, teachers, lawyers, brokers, manufacturers of everything on earth, writers, publishers, advertising men—the well-to-do of all sorts and degrees.

These constitute the great body of national park visitors. We

also meet the workers in lesser numbers—farmers, small employers and the thrifty employed.

Imagine an average of church congregations and the audiences of theaters, concerts, popular lectures, grand opera and the better motion pictures houses, of college football crowds and the patrons of the Chautauquas and Ocean Groves of the country, and you will come pretty close to the average of national park visitors. It is an intelligent and a fairly educated crowd. It represents America very well.

Of enormous economic importance is the system's strong tendency to redemocratize in a period which needs it. Nowhere else do people from all the states mingle in quite the same spirit as they do in their national parks. One sits at dinner, say, between a Missouri farmer and a Utah miner, and at supper between a New York artist and an Oregon shopkeeper. One stages it with people from Florida, Minnesota and Idaho, climbs mountains with a chance crowd from Vermont, Louisiana and Texas, and sits around the evening camp fire with a California grape grower, a locomotive engineer from Massachusetts, and a banker from Michigan.

Here, the social differences so insisted on at home just don't exist. Perhaps for the first time one realizes the common America —and loves it.

It is the democracy and the sense of common ownership in these parks that work this magic. They have rediscovered to America the American people. Elsewhere travelers divide among resorts and hotels according to their ability to pay, and maintain their home attitudes. In the national parks all are just Americans. It is difficult to imagine an institution making more powerfully for national solidarity than this annual congregation of a million and a quarter Americans from all the states.

We need not dwell upon the purely recreational values of the national parks, because they are self-evident. No other wilderness areas in the world are equipped, acre for acre, as these are with hotels and camps and public camping grounds, with roads and trails, for the pleasuring of the people. Though recreation is the national parks system's secondary purpose, shared with many other wilderness reservations, national and state, it here reaches its highest expression.

But we are nearing a danger limit. So rapid is the increase of travel to the parks that it is none too early to anticipate the time when their popularity shall threaten their primary purpose. This amazing era of travel is in its mere infancy. Motor touring and wayside camping are destined to increase many fold. If for no other reason than to protect the purpose of our national parks sys-

tem, we may do well to consider the large development of the admirable recreational areas in the national forest and perhaps the creation of a system or systems of purely recreational reservations elsewhere in the public lands. There must be new outlets or our conserved park system will suffer. While we are fighting for the protection of the national parks system from its enemies, we may also have to protect it from its friends.

The limits of this paper prevent even the enumeration of other economic aspects of our national parks, of which there are many. Those I have emphasized are in my opinion their greatest. The discussion of their value to adjoining states as concrete income-makers itself would need a paper. Their value to railroads and local business as nationwide travel-makers can never be computed; they are the headliners in railroad advertising and motor touring prospectuses the country over. Their income-producing value as lures for foreign travel here is destined to become very great; steamship lines and international travel agencies already are preparing for its coming. In fact, its beginning is here.

Time permits no further catalogue, but to this audience I must at least mention the fact that they are much the largest, and in two instances, at least, Yellowstone and Mount McKinley, the most important of our wild animal reservations. The last of the Shiras elk and of the unherded buffalo live in their ancestral corner of Yellowstone rarely even spied upon by man. One of the last small bands of the swiftest and most graceful of American wild animals, the prong-horn antelope, doomed, alas, to quick extinction, ranges her opens. McKinley's vast herds of caribou, and the innumerable big horn sheep upon her cliffs have been protected just in time.

I close with a suggestion which deserves thoughtful consideration. The reorganization of the administrative departments of the government which the President will urge upon the next Congress contemplates the creation of a Department of Education and Public Welfare; and in this new department the national parks service undoubtedly would find a more sympathetic and effective background and administration than grouped with the scientific and engineering bureaus which it is purposed to concentrate in the Department of the Interior. The engineering work in the national parks, confined to the building of roads and trails, is merely incidental to general and specific purposes which, even now, find little in common with the bureau's present environment. Our national park service is in its best and fullest sense a service in the interest of education and public welfare, nothing less and nothing else.

The American Association for the Advancement of Science has already importantly influenced national park policy by protest

against the importation of foreign species. We hope for its future hearty cooperation in many ways in order that this nation may realize in full measure the benefit of our national policy of complete conservation.

CONSERVATION OF THE QUALITY OF THE RURAL POPULATION

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IN these days of reconstruction there has come to the front again the old question of the relation between population and food supply. Even if we are not convinced by the arguments intended to prove that the world is approaching the point of population saturation, we can not fail to recognize that the effort to provide for an increasing population must soon involve either greater food production or a further lowering of the standard of living.

We can not go far in considering this question without discussing the relation of the farmer to the probability of an overcrowded world. We already have our alarmists who think that the drift from country to city, even in America, has come to be very serious. They regard this drift as the prime question in conservation, and they want something done to stop the flow from the farm. Of course the immediate answer to these worried souls is that with the use of farm machinery and the improvement of farm methods fewer farm workers are needed to feed the rest of us, and that the adjustment between food producers and food consumers will work itself out on sound economic lines.

Nevertheless, the problem of possible overcrowding is not entirely settled by this prompt reply. We know that the question of possible overcrowding is not spatial—there is standing room for billions more. Nor is it much a matter of shelter or clothing, because for centuries to come wood and iron and steel and clay and the fibers are likely to suffice for world needs. But when we come to food we do need to have concern. The amount of good soil was always limited, and the human race thus far has been inclined to waste even this patrimony of soil fertility. Now while the question of food depends upon the farmer it does not depend primarily upon the number of farmers. There are other factors, such as the maintenance of soil resources and the rehabilitation of those already partially wasted—no man knows the extent to which this rehabilitation can take place, as indeed no man knows the extent

to which unused tracts can be made sources of supply; the skill of the farmers; their ability to increase production per unit of land while maintaining fertility and at the same time keeping up their own standard of living; the economical distribution of food, the great problem of the next two decades; the changes in dietary of the consumers. On this last point, for example, there can hardly be any doubt that population pressure will gradually force people to emphasize the vegetable rather than the meat diet.

The man who holds the situation in his hands is the farmer. Two thirds to three fourths of the world's population consists of farmers and their families. The world's food supply is dependent upon these people. The conservation of what is by far the greatest natural resource of this earth, soil fertility, is wholly in their hands. They furnish a major part of the raw material for manufactures and commerce. They are potentially the largest consumers of urban wares. If intelligent, they forward the democratic movement; if ignorant, they retard it.

But this is not all. Shall we ever practice the precept which we know to be true that life is more than meat, that the economic fabric is only a scaffolding on which to work in the erection of quality of human life? As a matter of fact our fundamental question is not maintaining economic power nor political strength nor even intelligence, except as those things are both the result of and are used to develop qualities of mind and spirit. It has been shown to be quite possible to secure a national agriculture which is economically efficient, where at least the return per acre is very high even though the return per worker may not be large; and that men of the soil under such a regime may possess great thrift, may be contented and happy, and may through cooperation even develop considerable group power. I am describing here a thoroughly peasant regime. But in America at least we have to be persuaded that this status is satisfactory.

So much for a broad statement of the problem of maintaining the quality of our rural folk. Now to the solution. Of course the problem of conservation of the rural people is not in essence widely different from the problem of conservation of urban people. But the conditions of rural life differ widely from the conditions of city life, so widely that rural psychology is not urban psychology. Rural institutions can not be handled in the same fashion as urban institutions. So we get the rural problem, which, in all its practical aspects, is different from the city problem.

The prime need for the immediate future among our rural people is the conservation of intelligence. The whole farm stock in America has never been excelled and probably never equalled. At

the start it was essentially the same stock that dwelt in the towns and cities. Indeed, for a period of two generations in the nineteenth century our cities were built out of our own farm people. This high quality of rural folk in America is exceptional. There have been places and periods in the history of the world, such as in the earlier days of the Roman Republic and of the heyday of the English yeomanry, when the farm people could hold their own in the existing civilization. But as a rule the farmers have been underlings; so much so that the very words "boor," "rustic," "heathen," "pagan," and even "clown" and "villain" find their roots in the soil. The basic distinction of our American farmers, as contrasted with these other groups, is in the degree of intelligence. We can not here debate the question whether the intelligence of the American farmer is or is not being maintained. We can say, however, that there is the most serious danger that it may not be maintained, and this in spite of the great influx of "ignorant" immigrants to our cities.

Following closely upon the heels of this phase of conservation is the question of the health of the rural people. The last two decades have wrought great changes in the field of public health as it relates to "urban versus rural." The difficulties of distributing health information, of enforcing health regulations, of providing public health facilities are much greater in the country than in the city, and in some regions of the country these difficulties override the natural health resources of the country in the form of pure air and fresh food and abundant physical exercise.

Economic efficiency is a third item to be considered. On the side of production, I think the American farmer has held his own on the whole with other classes. It is popular to call attention to the tendency of the farmer to do as his grandfather did, to fail to keep accounts, to leave his tools in the field, but it is very questionable whether all the wastes in agriculture aggregate any larger relative item than the wastes of manufacturing, when we consider losses from misplaced capital, the scrapping of machinery, and the restriction of labor output, not to mention poor management, labor troubles, and the rest. To say all this, however, is not to deny the chance for vast improvement in the efficiency of producing plant and animal food. The ideal, of course, is that every acre of tillable land shall produce its maximum, but still retain at least its original fertility unabated and if possible increased.

This slogan, however, immediately opens the door to the entrance of another factor in the economic efficiency of American agriculture, and that is the problem of distribution. We are now in the throes of a great effort to solve that problem. To use a popular

phrase, the difference between the consumer's dollar and the producer's dollar must be decreased. The "spread" is too wide. Here is a vast complicated field of reform. There is but one country in the world that seems to have worked it out successfully, and that is Denmark, with a small territory, a simple agriculture, and remarkable unanimity of sentiment, acting under terrific pressure of outside circumstances. If, during the next generation, the American farmers even approximate the success of Denmark, we will be fortunate.

Of course, the great all-inclusive problem of conservation is that of conserving social power. Doubtless in an industrial age the main item in social status is economic efficiency and power; that we have already discussed. But it is not the sole term. There are other considerations. The joy in work, the appreciation of environment, the attitude toward other classes, the ideas and the ideals of the rural people, yes, their religion, are after all the great human items in a conservation program. In other words, American rural civilization must be just as broad, just as deep, just as humane, as any other part of our civilization. Not only that, but it must also make its contribution to our total civilization. It must play its part in great affairs. Social power, in other words, does not consist alone in successfully maintaining group strength and group rights. It consists also in an instinct for asserting itself in every field of social reform and endeavor. For example, the working out of satisfactory international relations does not lie wholly with the diplomats, nor with the statesmen, nor with the traders, nor with the bankers, nor with the prophets, but some of it resides with the farmers at work on the soil.

Now a word about the main forces to be relied upon to secure conservation. As I see it, there are two, both old-fashioned, but fundamental. One is education, the other is organization. We have rural schools in every community, we have the most elaborate system of agricultural education in the world, but we have yet a long way to go before we have an adequate system of rural education. In general the rural schools are not keeping up with the city schools. And, splendid as is the work of our extension education in agriculture, it has not yet begun to develop in a systematic fashion either the agencies or the methods necessary to meet the situation. In this presence, I do not need to dwell on this problem of education.

The stock arguments for organizing group endeavor do not as a rule include the educative value of organization, that is, the human improvement aspect of it. This is natural because the first endeavor of associated effort on the part of a group is to retain old rights or to secure new ones. The association arises because

these rights are endangered or have passed, and so there ensues a group warfare, and interest in the militant aspect of the problem comes to the front. As a matter of fact, however, the development of individuals within the group and the inclusive social power of the group itself are tremendously advantaged by associated or collective effort. This is quite as true of farmers as of labor or any other group. I should not look for any adequate solution of this problem of conserving rural people unless they can become thoroughly organized for all economic and social purposes. . . .

There is no opportunity in this paper to discuss a constructive program. A list of apparently dogmatic assertions may, however, be made covering the more significant points in a well-considered working program of rural conservation.

(1) The country children and youth should have opportunities for education fully equivalent to those offered the city-dwelling children and youth. This is not now the case.

(2) Our system of rural schools should provide education for those who wish to leave the farm as well as for those who stay; should stress vocational training for farming and rural home-making; should appreciably enlarge facilities for high school education.

(3) Financial aid to rural schools from the federal government will probably do more than any other one measure to stimulate this efficiency and broaden the scope of rural education.

(4) The American system of agricultural extension is the most stupendous scheme of adult education in the world. But we have yet to develop a satisfactory plan of permanent rural community forums or discussion centers as well as a system of study clubs and reading groups.

(5) Organization is a principle that goes far beyond mere collective or group efforts, important as those are. The main needs of the immediate future are (1) the organization of real local rural communities, each with its own program; (2) state, regional and national programs which not only project the larger issues but which actually secure the cooperating allegiance of all the agencies and institutions that can help. (3) A realignment of existing agencies in terms of their functional efficiency in these local and wider programs, rather than in terms of institutional pride, power or mechanism.

(6) A "campaign" of public information among the urban groups, to the end that they may come to a fuller appreciation of their interdependence with farmers, and the significance and difficulties that lie in the rural problem, especially in its economic and social aspects.

(7) Education and organization should seek not alone the special group interests of farmers, but should quite as consciously endeavor to mobilize rural opinion and activities on behalf of the common needs of humanity.

(8) We should have a Rural Foundation, well endowed, free to study and to interpret without bias the fundamental issues involved in the effort to conserve the quality of the rural population in all parts of the world.

I have used the word "quality" as indicating in a large way those powers and characteristics that spell effectiveness and social capacity. There are, however, certain specific qualities, certain habits of mind among rural folk, that are well worth possessing. Their thrift, their simplicity and directness of thinking and acting—these and other qualities do seem to be engendered by the rural environment, and more than once they have been a bulwark of our civilization. Of course we have to admit that rural environment may also develop other qualities not so pleasing. Nevertheless, on the whole the qualities engendered by the rural mode of life are substantial, worth while, significant.

The wise man of Ecclesiasticus long years ago asked this pointed question, "How shall he become wise that holdeth the plow, that glorieth in the shaft of the goad, that driveth oxen, and that is occupied in their labors, and whose discourse is of the stock of bulls? He will set his heart upon turning his furrows and his wakefulness is to give his heifers their fodder." And in this wise man's opinion, so also is every artificer and workman, the smith sitting by the anvil, and the potter sitting at his wheel. "All these put their trust in their hands and each becometh wise in his own work." They have the fundamental task of maintaining "the fabric of the world." But there follows this significant addendum, "They shall not be sought for in the council of the people and in the assembly they shall not mount on high; they shall not sit on the seat of the judge; and they shall not understand the covenant of judgment; neither shall they declare instruction and judgment." This ancient social distinction between those who work with their hands and those who do not still maintains in practice in most countries. In America we have rather prided ourselves that the line could not be so sharply drawn, and we have worked for and found wisdom among the husbandmen and the artificers.

In our thinking about how to conserve the quality of the rural population, therefore, we may take our departure from either one of two points of view. We may take for granted that the great task of the tiller of the soil is to be supremely efficient in that

function and that alone; or we may treasure the hope that in the evolution of human institutions the rural group, with respect to intelligence and education and social capacity generally, shall quite hold its own with other groups.

THE CONSERVATION OF HEALTH

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Introduction

TO present a comprehensive picture of what is implied by the extremely common term "conservation of health" is a difficult matter. When this topic is under consideration we are not dealing with something to be weighed by the ton, measured in board feet or calculated in kilowatts but with a subject whose inherent qualities defy exact measurement or even precision of definition. It is a subject concerning which, curiously, almost every one has some rather definite convictions, but one in which the formulæ of one group may be entirely rejected by another group. As soon as the value of a scientific fact in preventing disease or increasing vitality has been adequately demonstrated, one type of human mind concludes that this fact or discovery ought to be forthwith applied to the entire population willy-nilly. But there also exists another type of mind that tends to consider all health work as partaking in varying degrees of the faddish in quality and to look with skepticism upon all alleged advances in health conservation. This attitude seems to be due partly to the fact that the results in life saving or kilograms of additional physical energy can not be accurately calculated and partly because this type of mind cherishes strongly the principle of the right of the individual to do just whatever he chooses.

Between the two extreme views, that of the impractical enthusiast on the one hand and of the sanitary cynic on the other, must lie the real solid field of accomplishment in health conservation. There is, I feel, an actual danger from unbridled enthusiasm in health conservation proposals. It is conceivable that human life might become so completely safeguarded against accident, infection, fatigue, systemic toxemias and mental and nervous strain that existence itself would become so monotonous and boring as to be almost not worth while to a large proportion of individuals. On the other hand, the carrying out of the doctrine of individual "self determination" to the extent of refusing to admit the truths of science or of refusing to admit the existence of any obligations

on the part of government to citizens, parents to child, employer to employee, or individual to the community, in health matters, is a terrible thing to contemplate. Yet there are elements in our national life, some active, noisy, self-seeking, others earnest and fanatically sincere, who unite in propaganda whose objective is nothing less than the destruction of all governmental or private efforts for the conservation of health.

Health conservation has one underlying peculiarity which is shared by but a few of the other subjects concerning which conservation is a live issue. The conservation of health can never be completely achieved in its broadest sense by statute or by the expenditure of money alone, important as both these considerations are in any sane national health conservation program. The conservation of health depends in the last analysis upon the conscious desire and conscious voluntary response to that desire of animate, free agent, human units acting sometimes collectively, sometimes as individuals.

Part I. Health Conservation of the Past

It has been aptly said that the only guide we really have in planning for or in predicting the accomplishments of the future is the experience of the past. Only by tracing back to its beginning can the present structure of health practice be properly evaluated, present problems seen in perspective, or future trends even tentatively predicted.

It is noteworthy that this whole subject is of remarkably recent origin. There is some temptation to go into the splendid achievements of antiquity in certain lines of health promotion as exemplified by the systems of the Roman baths or Grecian athletics, for instance, and deduce from these isolated instances that there was a sound intelligent system of health preservation operating in classical days which was lost to the world for a long time thereafter. But save in the important sense in which security of property and safety of life tend to encourage higher standards of comfort and nutrition there is little to justify the assumption of the existence of a clearly comprehended general program of health conservation during the classical period. This statement does not mean that there did not exist a deep interest in health or in various carefully elaborated systems of dietary, exercise, baths, etc., designed to promote individual health, but community health measures were most rudimentary and totally ineffective in periods of epidemic or disaster, and superstition or irrational and nonsensical theories were more apt to determine lines of hygienic procedure than scientific knowledge or even common sense.

Down to relatively recent days two prevailing theories fought for control of communal and personal health policies. The one that gradually predominated and settled for centuries like an incubus over all attempts at advance was the theory or belief that all illnesses, pestilences and deformities were a direct manifestation of Divine wrath and hence that it was nothing short of impiety to make any attempt towards their control. This theistic point of view reached its climax in the latter middle ages and is perhaps no where more graphically expressed than in the words of an orthodox physician of the city of Reggio, Italy, when the reigning dukes (brothers and apparently men in advance of their times) during a plague epidemic introduced the revolutionary procedure of forced isolation of the sick from the remainder of the people, with the further drastic provision that if any parish priest or civic authorities failed to report cases coming to their attention at once they would suffer the death penalty. All this occurred in the year of our Lord 1374 and the comment of the orthodox physician of that day is as follows, "And I saw in this same year that these orders were observed in Reggio for which cause all were more grieved and terrified than by the fear of the pestilences, which, when God permits it, can not be arrested."

The type of mind which sought for rational and natural causes as an explanation of pestilences and epidemics was always hopelessly handicapped by the lack of any concept of the nature of microscopic life. Hence for centuries the scientific world elaborated and discussed theories of "miasmas," "atmospheric corruption" and the like which make pathetic reading to-day in their blind gropings for a natural explanation of the destructive whirlwinds of epidemic disease which periodically devastated the ancient and medieval worlds.

Apart from their inevitable limitations in the fields of epidemiology and sanitation the ancient physicians, who were often also priests of various shrines, evolved systems of personal hygiene and courses of treatment at various famous health resorts which were based on sound commonsense principles and produced results.

Where Modern Health Effort and Preventive Medicine Begin

Modern preventive medicine or hygiene may really be said to date from the discoveries of Pasteur in the world of bacteriology. The beginning of modern conceptions and practice in the field of sanitation in general and in sewage disposal and water supply and housing improvement in particular antedated the era of Pasteur by over a generation and to them modern health practice is under a great and everlasting obligation. It is not illogical to call the

earlier phase of present-day health practice development the era of sanitation or sanitary engineering. The epoch-making discoveries of the pioneers in bacteriology naturally took some time to reach even the leaders of medicine and general science. In fact, it was not until the late 80's of the last century that the leaders of clinical medicine in either Europe or America can be said to have generally accepted, with all the revolutionary implications contained therein, the demonstration of the existence and practical significance in health or disease of the bacteriologic world. The principles of modern sanitary engineering were already being steadily applied with notably beneficial results in matters of housing and community sanitation, but the demonstration concerning the micro-organic world was soon put to practical utilization in water and sewage filtration by sanitary chemists and engineers. One great plague, typhus fever, was placed under control during the earliest stages of modern sanitation. It might almost be said that, like Hercules, the infant science of sanitary engineering throttled this monster in its cradle before it was old enough to comprehend the significance of its efforts.

Without attempting to follow chronological sequence or to place any emphasis as to their relative weight as factors in our present day body of public health practice several elements entering into the modern health movement deserve passing reference. All have played a definite part in our achievements in these directions. Some of them are exclusively concerned with health conservation; others have come into play as a result of economic or social advance and their great health significance has often been entirely overlooked even by lifelong students of sanitary science.

The Factor of More Widespread Education

Foremost among these is the growth of modern education. It is sharply questioned to-day by some whether our modern system of universal literacy and diffusion of information really constitutes education. One brilliant student of human affairs in an article recently contributed to a leading American magazine frankly takes the ground that we have made no real advance over Hellenic civilization in true education. Be that as it may, I firmly believe that modern public health achievements would have been utterly impossible save by imparting a rudimentary understanding of modern sanitary science to the masses in school and by our books, papers and magazines. Lacking an at least partially-informed public opinion in these matters, progress in modern health endeavor would have been far below its present mark. The remnants of ancient and medieval pseudo-science transmuted into the superstitions, folk lore and "old wives' tales" of modern times still remain one

of our greatest obstacles to the more universal acceptance and application of the life-saving principles of hygiene. If the influence of our modern school systems and the dissemination of knowledge generally by books and periodicals were not partially neutralizing the subtle mischief of these inheritances of barbarism and superstition, the passive resistance offered thereby to the progress of hygiene would be almost insuperable.

Relation of Insect World to Disease

A prominent place among the factors of modern health development must be reserved for the far-reaching discoveries of the relationship of the insect world to disease. The knowledge of the relationship of the mosquito to malaria and yellow fever, and of the flea to bubonic plague, to cite outstanding examples only, has been of great significance to all of us, and not only has this knowledge resulted directly in great saving of human life, but indirectly it has meant much already and in the future can not help but mean vastly more in greater freedom of intercourse and trade among nations and in the opening up of vast areas of the world's surface to agricultural or other uses.

Extension of Food Resources

A matter usually ignored in consideration of the factors of health conservation is the matter of food supply. I am not now considering the problem of personal nutrition or proper balance of metabolism. The thought it is desired to bring out here is the hygienic importance of having enough food of sufficient variety produced and distributed at a cost which the masses can meet. Here is the true cause of much of the happy results of modern life saving for which we are altogether too prone to give credit exclusively to the laboratory and microscope, the surgeon's knife and the physician's pill. Among the many startling object lessons of the great war none has been more dramatic than the revelation of what a period of widespread inadequate nutrition means in the morbidity and mortality tables of a nation or community. In looking back we see plainly that it was the recurring famines, followed always by fearful pestilences, which largely account for the almost incredible mortality rates of the middle ages.

Modern health work is under tremendous debt of obligation to those discoveries in soil chemistry, to both animal and plant breeding and to the invention of modern agricultural machinery, which together have resulted in the present standards of quantity and cost in the matter of food production.

Factor of Improved Transportation

Bountiful production of food at reasonable cost is not by any means the whole tale of the fundamental bearings of the subject

of food upon health. Transportation and preservation of food by various devices have played a large part in making possible the all-year-round supply of a dietary adequate for the maintenance of the metabolism of the masses on a basis never before remotely approached. Rapid transit, modern canning processes, cold storage have all contributed to this phase of advance in health conservation.

Improved Standards of Living

Another factor which has entered largely into the evolution of better health standards has been what is commonly comprehended by the phrase "standard of living." This is an expression which does not lend itself well to exact definition. It implies matters of esthetics as well as matters of sanitation, but in such details as increased facilities for recreation and exercise, better-ventilated, heated and lighted houses, workshops and buildings devoted to commercial, educational and amusement purposes, it has contributed much to the conservation of our health.

One phase of the "improved standards of living" phenomena deserves, though it all too seldom receives, special recognition for the part it has played in health promotion, and that is the development of the science of plumbing. Nothing more clearly illustrates the advance in health conservation of the past century in this country than the great advance in the amount of water per capita that is used by the average person or family to-day when contrasted with the corresponding water consumption of a few decades ago.

Effect of Improved Hours and Conditions of Labor

A factor in the gains of our era in health promotion and life prolongation that can not be ignored is the economic or more often the combined economic and sociologic factor. A leading American public health authority[1] concludes a recent critical study of the causes of our present striking decline in tuberculosis deaths with the statement that the improved earning capacity and shorter hours of labor of the average American wage earner have contributed more to this decline than all the institutional and medical care and general educational aspects of the anti-tuberculosis movement combined. Perhaps not all will be willing to go so far as this, but that such a statement can be made by a qualified expert in the field of preventive medicine and be generally accepted in medical and sanitary circles as a substantially sound scientific judgment is the best possible evidence of the degree to which modern sanitarians

[1] Emerson, Haven: "The Factor of the Declining Death Rate for Tuberculosis," *American Journal of Tuberculosis.*

look to the field of economics and sociology for furtherance of their objectives.

Both the amount of compensation of the worker and his hours of toil are of deep significance in determining the general health of the community. It is also true that specific safeguards against the hazards of industry are a prominent part of any health conservation program. From industrial stress and strain, from extremes of temperature in industry, from dust, smoke and fumes, from undue general or local fatigue come much physical impairment, shortness of life, industrial inefficiency and community impairment. The rapid growth of the science of industrial hygiene has been the answer of industry to the significance of these discoveries.

Hours of and Character of Labor for Women and Children

Growing appreciation of the significance of woman as the replenisher and of the child as the hope of the race has wisely led to safeguards such as the world has never before witnessed against the exploitation of the mothers or the children of the nation by industry. It is too early yet to determine the full effect of these still only partially-realized national policies, but that their contribution towards greater national vitality will be a substantial and important one is beyond question.

The Contribution of Medical and Laboratory Science

Having considered a few of the most important underlying contributions to health advancement it is now appropriate to weigh the significance of those factors usually thought of when the terms "health work" or "preventive medicine" are used. Reference is meant to the direct bearings of research in pathology, bacteriology, physiological chemistry, entomology and their newer subdivisions, together with the contributions of clinical medicine and epidemiology proper upon the cause of health conservation as weighed and evaluated by the methods of vital statistics. This is what is commonly meant when the term "public health" is used. The successes of modern science against such immemorial enemies of human life as Asiatic cholera, hookworm, smallpox, diphtheria, scarlet fever and a long roll of less well-known diseases can be traced back almost exclusively to bacteriological laboratory discoveries supplemented by careful clinical observation and as a result of careful study and correct conclusions as to their significance, the application of practical methods of prevention. In the case of such maladies as yellow fever, typhoid fever, malaria, bubonic plague and typhus fever, the same bacteriological-medical factors have been prominent, but the sciences of entomology or engineering have had to play an equally important rôle before success could be achieved.

In the case of another disease group of great destructiveness to human life and efficiency, the so-called "venereal" infections, in addition to the discoveries of the laboratory and hospital, ethical considerations must be depended upon for any great or permanent advance.

The Phenomenon of Health Departments and Other Organizations

Step by step with these discoveries has grown up during the past fifty years a remarkable number of agencies designed to function exclusively for the preservation of human health. Some of these are agencies of government operating under different names and given very widely differing prominence all the way from the health department whose whole aim, object and reason for being represents the reaction of modern organized society to the challenge of health conservation, down to very minor organizations in governmental departments whose primary purpose is remote from health, but whose everyday functioning uncovers specialized health problems for the handling of which it has been found necessary or advisable to create special health machinery.

Side by side with these health departments have also gradually come into existence a vast host of non-governmental agencies whose objective is the promotion of health. These range all the way from the vast endowed organizations, as the International Health Board of the Rockefeller Foundation, for instance, with a budget and resources far in advance of practically all governmental health departments down to the smallest village's band of public-spirited women who have united to ensure the services of a home visiting nurse for the community. In the promotion of health the influence of these organizations in the aggregate has been tremendous.

Statistical Record

Now let us see very briefly what the record of fact shows in the gains of health conservation up to the present. After all, the crucial test for health conservation to meet is not so much what may be its province in the future, but what it can show in the matter of past performance. Happily for students and practitioners of sanitary science in this respect we are on much firmer ground than the special pleaders for many other forms of conservation. To present an elaborate statistical analysis as a basis for this statement, interesting though it might be, would unreasonably prolong this paper, hence I will merely cite a few salient features of Massachusetts' experience, with the general qualification that they may be accepted as typical of all localities where the occidental type of civilization prevails.

In Massachusetts the average yearly death rate from all causes from 1885-88, inclusive, was 19.5 per 1,000 population; for 1920, the rate was 13.9 per 1,000. This means over 20,000 more lives were prolonged in comparison with the rate of about thirty years ago.

The infant mortality rate of Massachusetts in 1885 was 156; for 1921 it was 76. It means that whereas in 1885 a new-born infant had only a little better than five chances in six of living to celebrate a first birthday, now less than one child in ten dies under the first year—a most creditable gain but still a fatality hazard much higher than we know to be necessary.

The death rate for pulmonary tuberculosis in 1885 was 307 per 100,000; in 1920 it was 96 per 100,000. It means that if the tuberculosis death rate had remained to-day what it was in 1885 in place of approximately 3,300 dying this year from consumption the number would have been over 12,000.

In 1885 the typhoid death rate of the commonwealth was 39 per 100,000; in 1920 it was 2.5. This means that, whereas less than 100 people died from typhoid in 1920, had the same rate prevailed as in 1885, 1,560 would have died.

In 1885 the death rate for diphtheria in Massachusetts was 78 per 100,000 of population, in 1920, 15 per 100,000 population.

In 1885 the death rate of scarlet fever per 100,000 population was 30.2. In 1920 it was 5.5 per 100,000 population.

Or it is perhaps more graphic and comprehensible to reduce the matter to terms of average expectancy of life at birth.

In 1885 the average expectancy of life for a new born baby (male) in Massachusetts was 42 years approximately; (female) 43.5. Both sexes average 42.75 years. In 1920 the average expectancy was 53.98 (male), 56.33 (female); both sexes, 55.1 years.

Upon reflection we can see that up to a period roughly coincident with the end of the first decade of the present century all the influences operating most prominently in connection with health conservation have certain features or characteristics which mark them off to a certain extent from the health conservation of problems of the present and near future. In general it may be said that hitherto the greatest emphasis has been placed and the greatest advances made in the field of infectious disease prevention and control. It is also quite obvious that except in the case of the infectious diseases such gains as have been made in promoting the health of the individual or the mass have often been due to the accidental or unexpected results of some improvement in industry, transportation, recreation or sociologic endeavor rather than to a conscious deliberate attempt thereby to improve the health of the individual or community. It may also be said with a high degree

of accuracy that the health advances of the recent past have generally represented those things that could be done for the average citizen rather than those things which he had to do for himself.

As we turn to consider the future problems of health conservation we will note that all three of these factors will cease to be as proportionately effective as heretofore and must be replaced by procedures along radically different lines if the full potential benefits of a sound national health program are ever to be realized.

Part II. Health Conservation of the Present and Future

I have traced roughly some of the sources from whence our present health-conserving agencies have sprung and have drawn attention to the crude proof of their accomplishments as registered in increased average longevity and decreased fatality from specific morbid processes.

Broadly speaking, no such results have ever been remotely approximated before in the world's history—Egypt, Hellas, Rome, India or China knew nothing like it in the days of their greatest glory. This record of achievement is one thing which sets our era on a pinnacle apart from the remainder of recorded human existence. To be sure, deep concern over the human misery arising from bodily affliction has long been a great moral force in the world but it is only in our own times that humanity's struggling aspirations for the alleviation of suffering have been translated into scientific achievement.

An outstanding feature of present-day health aims is the degree to which they recognize how far the lengthening of average expectancy of life up to the present time falls short of the full possibilities to be attained as an outcome of a comprehensive well-rounded national health program. Past accomplishments in health improvement have consisted largely in triumphs over environment and in control of infections. It is in hookworm and malaria eradication, in diphtheria control, in the tuberculosis decrease that we read most clearly our claims to distinction. In building up the well-poised body and in cultivating the serene mind we can point to no such clear-cut victories. In these respects some authorities do not consider that we can even equal the actual accomplishments in personal hygiene that were achieved by the citizens of ancient Greece.

It should never be forgotten, however, in making such comparisons that the free citizenry of ancient Greece never represented more than ten per cent. of the total population. No records have come down to us relative to the hygienic conditions or mortality rates of the slaves and serfs who represented ninety per cent. of the populations of antiquity. When proper allowance is made

for the status of the slave in classical times, I am reasonably certain that our average achievement in personal hygiene to-day far surpasses the average standards of antiquity.

But to revert, it is an inescapable fact that most of our gains in life prolongation hitherto have been in channels where either correction of faulty environmental conditions or an interruption of the chain of infection was indicated. It is a peculiarity of these two types of health activity that they can be carried out to a large degree by the mere passive acquiescence of the bulk of the community. It is obvious that even where efforts and results in these directions reach the maximum there will still remain untouched large segments of the health conservation field.

The Expanding Concept of Health

These newer and as yet untouched or only lightly touched phases of health development call increasingly for active participation by the individual citizen, and this question of the reaction between the offerings of science and their acceptance by the average American citizen in the field of health promotion presents one of the most fascinating problems of our present day schemes of human government and social relations.

There has sprung up in the past twenty years a greatly expanded concept of what health actually means. Now we are beginning to realize that but a small proportion of ostensibly well people can measure up to even very modest standards of good personal physique; that scarcely any of us out of a hundred pursue a reasonably sensible routine of personal hygiene.

To-day we are no longer satisfied with a mere negative definition of health. Health must mean something more than mere absence of acute disease. It implies a standard of personal vitality and physique that insures a positive enjoyment of existence due to a properly balanced, well-exercised, smoothly functioning bodily mechanism reacting agreeably upon the mental and emotional processes of the individual.

One of the outstanding difficult problems of preventive medicine is that of bringing home the extent to which avoidable sickness, inadequate or improper physical training in childhood and preventable accidents all considered together, slow down our national productiveness; absorb time, money and energy that could otherwise be devoted to the greater expansion of a national cultural life; result in increased delinquency and crime; and in general add to the sum total of preventable human misery. I will not go into exact statistics on this point. The publications of the National Safety Council present a mass of startling information as to the

burden of preventable accidents; the publications in recent years of the various social welfare organizations and of departments of correction, probation and charities of certain states and cities show how direct and extensive is the relationship between delinquency and non-social behavior on one side and physical deficiency or subnormal health on the other. We have begun to accumulate a certain amount of data on the magnitude of the burden imposed on society from occasional illness, a large proportion of which could be entirely avoided through sound intelligently applied systems of community, industrial, school and personal hygiene.

Inasmuch as such data on this subject as is available in this country is fragmentary and not checked by any nationwide machinery it may be more illuminating to quote the most recent British experience on this point.[2] This quotation is made without reference to the ability of the British system of state-supervised medical practice to correct effectively the condition disclosed. The impressive facts as to sickness prevalence are sufficiently startling in themselves without here going into any consideration of the proper answer to the national problem they so clearly indicate. The British health insurance tables show that "at least 14,476,000 weeks' work are lost on an average every year through sickness. . . . That is to say, in England and Wales there is lost to the nation every year, among the insured population only . . . the equivalent of the work of 278,000 persons (working constantly throughout the year) . . . it is not only the working equivalent of 278,000 persons that the nation loses every year, but also the labor and expense involved in their care during the 14,476,000 weeks of their incapacitation. To this loss of time and capacity among the fourteen million insured persons, we must, to obtain the (total) national loss, add a comparable (and undeterminable) though presumably not so large proportionate loss, in respect to the remaining twenty-three millions of persons, including children." So much for the facts of sickness prevalence.

The next finding of the British health insurance scheme is the one which opens up a wide range of discussion as to the reasonableness of this enormous aggregate amount of recorded sickness. It is reported that when the causes of sickness which result in this staggering amount of national non-productiveness are sought the absences from labor due to serious diseases such as organic heart disease or tuberculosis, for example, are relatively few, but it is what is generally known as the minor maladies, such as functional impairment of digestion or of kidneys, neuritis, neuralgia,

[2] Sir Geo. Newman: For year 1921, p. 27, Annual Report, Ch. Med. Off. British Ministry of Health.

sick headache, decayed teeth, tonsilitis, bronchitis and common colds, "rheumatism," etc., that are the principal causes for which these persons seek medical advice and absent themselves from work. In the aggregate these "minor ailments" produce a truly formidable amount of suffering, sickness, idleness and loss of income. An exceptionally large proportion of just such ailments are entirely avoidable by attention to personal hygiene. Hence we see that the preventive medicine of the future must seriously concern itself with this problem as well as with its present recognized duties in sanitation and communicable disease control. The question of how this problem is best solved, whether by an enormous extension of governmental activity into the realm of the private citizen's personal concern or by a great and revolutionary change in the conception of clinical medicine, is totally a different problem and not within the scope of this paper.

The Newer Terminology of Health

This swing of the pendulum away from consideration of mass groups of the population and towards emphasis upon the health problems of the individual is now very noticeable in all lines of health work and is the best evidence now available of the direction in which we may confidently prophesy that the future developments in health work will lead us. The very nomenclature coming into common use to designate the major divisions of health activity with the word "hygiene" occurring practically uniformly as the part of the name, as school hygiene, infant hygiene, dental hygiene, mental hygiene, for example, contrast sharply with the older divisions with which we have long been familiar—sanitary engineering, epidemiology, vital statistics—words indicating mass or group conceptions as sharply as the newer terms indicate the individual.

Enumeration of Prominent Health Fields of the Future

It will perhaps suffice, in view of the necessary limitations of the present occasion, to indicate some of the hygienic measures which I can already see coming into prominence in health conservation and which must inevitably come into much greater prominence in the future.

Eugenics

First of all comes the field of eugenics. Eugenics has become something of a football word, kicked about and mistreated by all sorts of special groups. That positive eugenic principles will ever become a significant feature of either national or personal hygienic practice has long seemed to me the height of the improbable. Despite the solemn pronouncements of a small group of enthusiasts

who preach the physical salvation of this world by the eugenic route, human nature has never shown any tendency to be guided by eugenic considerations in approaching the question of mate selection, and I see no reason to conclude that it ever will. On the other hand, negative eugenic principles deserve to be much better understood and it is reasonable to suppose that an important phase of future health development will be the education of individuals to a point where the dangers of perpetuating and multiplying racial defects by unwise mating will be so generally recognized that such traits as feeble-mindedness, for instance, will be gradually bred out of the racial stock.

Maternal Hygiene

Regardless of whether eugenic principles, positive or negative, ever become a prominent factor in health conservation, it is obvious that everything pertaining to the health of the mother must receive attention if real health advance for the nation is to be achieved. The health of the mother is so closely interwoven with the health of the infant that almost instinctively we associate the terms maternal and infant hygiene. And as Sir George Newman pithily put it: "Here is the source of the nation. From a physical point of view, what the mothers and children are the nation is and will be."

Child and School Hygiene

Passing beyond the period of infancy we find our hygienic nomenclature chiefly focused on the general term, child hygiene, and better to emphasize the methods by which child hygiene is to be fostered, such specialized terms as dental hygiene, school hygiene, physical hygiene or education, hygiene of nutrition and others not yet so familiar.

Passing on to adolescence and adult life still other terms are coming into wider use and into more intelligent comprehension by us as a nation. I refer to the terms mental hygiene, industrial hygiene, personal hygiene and all they imply. This list is not by any means exhaustive, but by this very terminology of the newer health program we apprehend clearly that back of them all must lie, first, education of the individual in hygienic principles and, second, an intelligent voluntary response on the part of the individual to this education if our health conservation program for the future is ever to be made effective. In fact, we may reasonably say that the health program of the future will be effective directly in proportion to the application of four fundamental factors each of which can only be suc-

cessful by the active participation of the individual citizen. These are, first, personal assimilation of the simpler principles of personal and community hygiene; second, personal volition or a will to put this knowledge into effect; third, an increased degree of self-control by the average individual with a corresponding increased ability to regulate by the rule of reason and moderation the ancient instincts of man whether they relate to sex, food, drink, pugnacity, work or sloth, or such mental instincts as fear, hate and envy, and fourth, an increasing instinct to regulate individual hygiene by the dictates of altruistic promptings toward our fellow men, which last may sound sentimental but in reality is coldly scientific as well.

Conclusion

The goal is now clear. It is to establish the span of average human existence upon the plane of the maximum average physiologic efficiency of the human body. Strictly speaking, up to the present time it has been only the very exceptional person who has lived a normal human life to its conclusion, for nearly all of us die prematurely. But now we know enough to change this; we know now that there is no such thing as an "inexorable law of mortality;" we know that "public health is purchasable and within reasonable limitations each community can fix its own death rate." We know that the classic statement of Babbage, "There are few things less subject to fluctuation than the average duration of life of a multitude of individuals," is absolutely erroneous and false when checked by the experience of our civilization for the hundred years that have elapsed since he laid down this once universally believed rule.

Obviously there is sufficient scientific knowledge extant, if intelligently and universally applied, to prolong the span of average human life by many years, and to make all these years much more abounding with the joy of living that accompanies top notch physical condition than is the case with the average person to-day. A committee of the American Public Health Association has recently reported that whereas average American life expectancy is now probably in the neighborhood of fifty years there is no insurmountable obstacle in sight of increasing that average expectancy by at least twenty years in the next two generations. Surely this is a goal worthy of our best endeavors.

CONSERVATION OF AMERICA'S ECONOMIC INDEPENDENCE

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THE title of these remarks was suggested long ago by a brief reference in the manifesto of the League of Nations Association, proposing that America surrender some of her economic advantages in the furtherance of the alleged cause of international good-will. It occurred to me at that time that no more unpatriotic or irrational proposal could possibly be advanced by those who were supposed to represent American interests in the discussions favorable to our joining the League of Nations, for, if there is any one duty, clear and emphatic, it is that we must conserve our economic independence, as much as we must leave nothing undone to conserve our political independence. To merge either or both into an international compact means the surrender of priceless privileges, for which we are under deathless obligations to a bountiful nature and the founders of the republic.

But in a much more serious sense we are in danger of sacrificing enormous economic advantages, by apathy, ignorance and greed. Our national resources have been and are being squandered at a ruthless rate, regardless of overwhelming evidence that we are not far from having reached the limit of safety. Of our imperial forest domain but a fragment is left to us, as a result of a scandalous policy of greed. Our coal-mining methods, in many respects, are crude in the extreme and priceless coal resources are forever being destroyed in the haste of making immediate gains, at the incalculable cost of future generations. In metal mining we are following a policy which is often destructive to the real interests involved, while in gold dredging we are destroying thousands of fertile acres, to be left a barren, rock-covered waste.

Nothing much of value has come of the conservation movement, in proportion to the enormous opportunities disclosed by early investigations of a decade or two ago. Our pulp supply is near the point of exhaustion, and practically nothing of real value is being done in the direction of reforestation. With the inspiring examples of certain European countries before us, our private and corporate forest policy still continues one of exploitation rather than of development.

Industrial waste has been the subject of countless essays and arguments, summarized in an extraordinary report prepared by a committee of the Federated American Engineering Societies

This report emphasizes the waste in printing, the waste in shoe manufacturing, in the manufacture of clothing, in the metal trades, in the textile trade and the building industry. It touches only the fringe of an immense question, but presents an unanswerable array of evidence, suggestive of the direction which we must take, if we are to preserve our economic superiority in the field of increasing international competition.

Among the evidences of a recognition of our duty in this respect, mention may be made of the admirable policy of the American Writing Paper Company to bring about standardization of products and processes in the manufacture of paper. Perhaps in no industrial field is there greater waste than in paper-making, printing and publishing, but happily few industries have more clearly recognized the urgent need of compromise upon standard sizes and standard qualities than these. It goes without saying that all needless waste is reprehensible impairment of our economic power. There is waste in water power, waste in wind and tidal power, waste of soil, and waste of water resources, which properly utilized would enhance the wealth and economic efficiency of this nation enormously. Bitter necessity will some day force us to adopt a more intelligent policy, but no necessity can replace natural resources and God-given opportunities that have been wasted and that are gone forever.

The waste of water-power is being recognized and some progress is being made towards the establishment of central power stations and distributing centers intended to serve the needs of rapidly growing population areas. The super-power project, which has been advanced to a point of practical consideration during the present year, is but one of many encouraging evidences of progress.

There is enormous preventable waste in our fisheries, and in the ruthless destruction of wild game, much of which has either vanished or is vanishing, never to be replaced. The last passenger pigeon died this year or last, a memorial to ruthless slaughtering of countless millions of birds, which might have served a useful purpose, if made a subject of rational economic and humanitarian conservation. The few buffaloes that remain are another sorry example of our apathy towards a policy of destructiveness which finds its explanation only in ignorance and greed.

In agriculture we are far from being as far advanced as we should be and the fertility of our soil is wasted by neglect in the prevention of soil erosion, all of which involves the destruction of priceless substances beyond the range of recovery. The amount of soil that is washed down the Mississippi River each year would, if

conserved, provide for countless millions for generations to come.

We are wasting our transportation possibilities by the precarious attention which we give to our vast inland river courses, subject to the changes of political fortune, or the expediency policy of political parties. What we need, perhaps, as much as anything, is a policy for the Mississippi River and adjacent waterways which will give us the cheapest mode of inland transportation at our command. We need also to provide rationally for terminal facilities, etc., so that we may reap the best possible results from investments which involve enormous sums of money.

We are wasting foreign trade opportunities by the precarious attention which we give to our great natural harbors, subject to fluctuating legislation, now liberal or parsimonious as the viewpoint of the party in power may decide. There are few more pressing problems than the development of a national port authority policy in strict conformity to our constitutional conception of the dividing line between government and private enterprise.

If we have been drifting with regard to rivers and harbors, we have been even more adrift with regard to a broad policy affecting the development of our national merchant marine. The costly experience during the war has left little of value in rehabilitating American shipping, and the outlook is not encouraging that the present and proposed subsidy legislation will meet the needs of a highly complex situation.

In one direction, at least, we have made most commendable progress and that is in the conserving of our internal banking power through the establishment of an efficient federal reserve system. We have not experienced since its organization the distressing panics of 1893, or of '67, or of '57, or of '47, as the case may be, but a deliberate policy on the part of the government safeguards the credit situation of the country, with reasonable effectiveness in times of emergency. The danger that confronts us at the present time is the dissipation of our banking power through foreign loans, insisted upon, in season and out, for the purpose of restoring foreign credit. Save in so far as we can legitimately extend liberal credit to Germany and Austria, until those afflicted countries are in a fair way to recover the millions of dollars loaned in non-productive governmental undertaking, must impair our economic independence, while not advancing the economic restoration of the countries immediately concerned. All such proposals aim at making America pay for the war and suffer economic consequences that she should justly be relieved from.

There are two sources of economic waste, less definite of precise ascertainment, but nevertheless of the very first importance.

There is an immense and largely preventable waste of labor time, due to needless strikes and labor controversies otherwise, which a more rational policy on the part of the government and on the part of corporations would reduce to a negligible minimum. Strikes and labor controversies but symbolize industrial warfare, as needless and unjustifiable as is military warfare in international relations. The railway strikes and the mining strikes of the present year involved inconceivable amounts of waste in productive labor, aside from a vast amount of waste in economic materials. The work that isn't done can never be made good, for each day brings its own demands and each day should be made the best and the most of. The prevention of labor waste should be made a paramount policy on the part of the government and should be as consistently aimed at, as a matter of everyday duty on the part of large corporations, as the waste by lapses in life insurance has been prevented by improved methods of executive direction.

The labor waste involved in a needlessly large labor turnover has during recent years been materially reduced to the considerable advantage to all concerned. The principle has been recognized that too much has been sunk in making a man an efficient employee to justify his sacrifice upon the precarious mood of a possibly prejudiced superior official. In time there will be recognized a higher duty that the loyalty that is expected of employees towards the employing concern likewise demands an even higher sense of loyalty on the part of the concern toward the employee. The vast unemployment problem of recent times, affecting nearly all industrial countries, suggests the adoption of a policy, which I have elsewhere defined as the establishment of an "industrial depression reserve" which will safeguard the interests of workers during periods of involuntary idleness, due to causes or conditions beyond the control of both employers and employees.

Finally, there is the enormous waste attributable to ill health. Safety and sanitation in industry during the last few years have fortunately made great progress. One corporation alone—the United States Steel—has spent more than $70,000,000 during the last decade in improving the conditions and fostering the safety of its workers in countless ways. Our death rate at the present time is the lowest in our history, and it has reached a point which even a decade ago would have been considered absolutely unattainable. It is now less than half of what it was thirty years ago. Tuberculosis has been reduced more than one half and typhoid fever, once the scourge of young people, is now practically a thing of the past. In the southern states, malaria is rapidly diminish-

ing, and from every source come reports that a policy of effective health conservation is being opposed to the destructive influences that always have and always will threaten the life and the safety of mankind. While much has been done more remains to be done. Most of the health conservation has affected the younger ages, but gradually we are beginning to understand the conditions under which life may be prolonged considerably beyond the scriptural threescore and ten. Old age is unquestionably being attained to an increasing extent, while vigorous manhood now extends far beyond the earlier years, in which in the past failure of health and strength was a matter of common occurrence. Apparently there are no reasonable limitations which man may not hope to be able to overcome by intelligently adapting himself to his environment.

As thus conceived, our economic freedom involves the supreme duty of a consecrated sense of intelligent living and of the rational use of all the means that a bountiful nature has provided for us. Conversely, it implies the sinfulness of a policy of greed, apathy and ruthlessnees, which sacrifices the present to the immense disadvantages of generations to come. If our fathers had managed as we are managing, this country to-day would be near to the European level instead of being the most prosperous and the happiest on the face of the globe. We shall fail or succeed in proportion as we realize our solemn obligation that the conservation of our economic independence is of equal importance with the maintenance of our political independence through a constitutional and republican form of government.

ON THE HISTORY OF PHYSIOLOGY AND SOME OF ITS LESSONS[1]

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TO deal adequately with the history of a science, such as physiology, one should be both a scientist and a historian. But at present the two functions are almost never found in one person. History, as ordinarily taught and practiced, is certainly the least scientific of all branches of knowledge. As a great scientist, Wilhelm Ostwald, in his lectures before the Rice Institute on the "Organization of Knowledge" has truly said, "the essence of knowledge organized as a science is the attainment of the power to control the future, or at least foretell its course."

Prophecy as practiced in science is not mere fortune telling to satisfy an idle curiosity, but guidance and direction for our acts and work. Astronomy foretells for the sailor the hours of the tides, the positions of the stars and for us all the occurrence of such events as eclipses and the passage of meteors. Some day it may even foretell the weather—and years ahead.

The prophecies of chemistry take the form of such conditional propositions as this: If you mix certain substances in certain proportions under certain conditions, you will get such an amount of such a product—be it rubber or leather or steel or dye. Physics likewise foretells that if we induce certain steam pressures in engines of a certain design, we shall obtain such an amount of power. Economics foretells that a rise of prices will result if too much paper money is printed. It is this power of conditional prophecy which is used to run trolley cars, and to light our homes and halls, and in general to make material civilization possible.

The history of science according to this view should be therefore not merely a chronicle of discovery, but an analysis of the relations of ideas and of methods to progress and the application of the conceptions thus gained to guide us in present and future work; for the fundamental idea of science—the idea which historians have not yet grasped, nor yet recognize as a duty even with

[1] The third of a series of lectures on the History of Medicine, by a number of lecturers, under the auspices of the Gamma Alpha Society of Yale University.

bleeding Europe before their eyes—is that in this world of nature and of man certain sequences of events continually recur, but never twice strictly and exactly alike, and that the business of organized knowledge is to define the principle of repetition, to show the extent and the reasons for the variations, and to suggest how mankind may mould the world to culture and civilization out of the "original sin" of nature.

When we face the topic of this evening with this idea in mind, the first consideration which presents itself is that in what we to-day call a distinct science, such as physiology, physics, or chemistry, we are speaking in reality of a strictly modern and ephemeral thing. Each has its roots and ancestors in the past, but so to speak, each makes itself out of the materials inherited from the past and ennobles its own ancestors. Moreover, each will probably in the future be divided up, its name transferred, or even forgotten along with astrology, alchemy and heraldry, and its various components recombined in other subjects whose names have not yet been even invented.

Such a subject as the physiology of A. D. 1922 certainly did not exist in 1822, any more than you and I existed then; and probably by 2022, our physiology will be with you and me and "yesterday's 7,000 years."

Before we go back to the past ages to trace the beginnings of physiology, we must define what particular conceptions and objects in the broad current of science we understand in A.D. 1922 under the word physiology. We understand two things, either or both of which enter into every problem in any of the various fields of physiology. May I illustrate by quoting from the recent Silliman lectures here by Professor Krogh? He was speaking of the physiology of capillaries and he said:

> As is generally the case in physiological research, we have a double purpose in studying the reactions of capillaries to physical and chemical stimuli: we want to find out the mechanism (in the broadest sense of that term) of every single reaction studied, and we want to find out also the meaning, the part played by the reactions in the delicate regulations by which the organism and the organs are adapted to the ever-changing environmental conditions.

The "mechanism" and the "meaning" of living creatures and their organs, these are the questions of physiology. It is because the mechanisms of living things are, as we now know, fundamentally the same as those of physics and chemistry, that we physiologists partake of the same heritage as physicists and chemists. We claim as part of the heritage of physiology Archimedes, with his ideas of levers and of specific gravity; Torricelli and his conceptions of the pressure of a column of liquid; Lavoisier and Liebig

and all those great names which are associated with the development of our ideas as to the conservation of energy and the indestructibility of matter. The very core of physiology lies in what we term metabolism, and the chemists term transformations of matter with no change of weight, and the physicists formulate under the laws of thermodynamics. From a mechanistic standpoint, Lavoisier was the greatest physiologist who ever lived and yet the chemists would certainly claim him as their own. But Lavoisier's work can not be divided into a physiological part and a chemical part. No, it was all chemistry and practically all physiology as well. Science is one, and I will venture the guess that perhaps one hundred years from now in a lecture here on the history of physiology, the lecturer may say, and say truly, that in the latter part of the 19th century there lived and worked in New Haven a physiologist as great as Lavoisier, a man who taught those principles of equilibrium in such chemical systems as the humors and cells of living organisms, upon which the ultimate explanation of life must rest—Willard Gibbs, a mathematical physicist.

Perhaps, some day in an infinitely distant future, physiology will thus be converted into a branch of mathematical mechanics. But when a problem of mechanism is solved, we still have before us, as Professor Krogh said in the passage which I quoted, the problem of the meaning, that is, as we say in physiology, the function of these mechanisms. Here we part company from physicists and chemists, for they utterly reject, or at least neglect, teleology nowadays. They can afford to; but in dealing with living things we must guide and check our work by teleological considerations or we may go far astray. As Aristotle put it 2500 years ago: "In dealing with respiration, we must show that this and that part of the process is necessitated by this and that other stage of it"—that is, its mechanism; and we must also "show that it takes place for such or such a final object."

On the other hand the standpoint of modern physical science regarding teleology is summed up in an anathema composed by Francis Bacon about 400 years ago: "To say that the hairs of the eyelids are for a quickset and fence about the sight; or that the firmness of the skins and hides of living creatures is to defend them from the extremities of heat or cold; or that the bones are for columns or beams whereupon the frames of the bodies of living creatures are built; or that the leaves of trees are for protection of the fruit; or that the clouds are for watering of the earth; or that the solidness of the earth is for the station and mansion of living creatures, and the like is well enquired and collected in Metaphysic; but in Physic they are impertinent."

For chemistry and for physics, and doubtless also for biochemistry and biophysics such conceptions are to-day "impertinent." But the formulation of such conceptions regarding the living body is the very essence of physiology proper, for the word physiology is derived from the Greek words *logos* and *phusis* or *physis*. It means the principles of nature; but *physis*, as Hippocrates used the word, means far more than nature: it is "the some thing working toward an end," the something which v.Leiden recognized when he said, "If you can only keep your patient alive long enough he will generally get well of himself." And here let me point out that no mere mechanism, such as an automobile, ever recovers by merely being left alone. In my experience even a broken spark plug always requires a surgical operation.

Now let us make a rapid survey of the great contributions both to the problems of mechanism and of meaning and see how they are related.

The mammalian circulation and especially the heart has probably been the object of more investigation than any other topic in science. Aristotle, whom Osler speaks of as the founder of physiology, as well as comparative anatomy, zoology, botany and some other sciences, recognized the heart as the central organ controlling the circulation, the seat of vitality, the place where the blood was finally elaborated and impregnated with animal heat. Aristotle did not distinguish between arteries and veins, but recognized that from the blood vessels throughout the body "the nutriment oozes like water in unbaked pottery."

A clearer view of some points, but not so on others, was reached by Praxagoras who taught in the celebrated University at Alexandria a quarter of a century or so after Aristotle. He recognized that only the arteries pulsate, but he taught that these vessels were really air tubes; only the veins containing blood. Hence he applied the word artery, which we still use, but which literally means an air tube like the wind pipe, the trachea, and bronchi. It was an odd mistake, but perhaps the following incident may suggest how Praxagoras happened to make it: Some years ago in connection with a lecture, I was demonstrating the anatomical relations of the heart and lungs of a big dead Newfoundland dog, when one of my hearers, a burly black bearded man, pointed to the aorta and asked what it was. I told him it was the great artery. "But," said he, "it never contains blood, for I have cut up many animals and have always found in it only air or a little bloody foam." Of course I was curious to know how he came to cut up many animals; and found that he was assistant Rabbi of an orthodox synagogue and that he koshered cattle, that is, cut their throats. Ap-

parently the dying gasps of an exsanguinated animal fill the aorta with air, as the Rabbi, and perhaps Praxagoras also, found, for the Bible tells us that koshering started in or near Egypt. Failure to appreciate the abnormal conditions in experiments on animals has led many modern investigators to almost equally erroneous conclusions in some of our problems.

The Alexandrians also described the valves of the heart, but it was 400 years later, that is, in the second century A.D., before Galen, the great Roman physiologist and physician, proved that the arteries contain blood. He did it by an experiment, not on a dead body, but on a living animal. He placed two ligatures a little distance apart upon an artery. "Now," said he, "if I cut the vessel, spiritus (or, as we would say, air) will come out, if Praxagoras is right; but blood if I am right in holding that the arteries are really blood vessels." Then he cut a nick in the vessel—just as every student doing a blood pressure experiment does nowadays to insert a cannula—and of course there was a little spurt of blood. But there he stopped and it was 1400 years before William Harvey, an Englishman, physician to King James the 1st, discovered and proved by ingenious experiments that the heart is a pump and that the blood runs in a circle.

It is extremely difficult for us to form a clear conception of some of the medieval beliefs regarding the living body and scientific matters in general, and I shall merely abbreviate here the account which Sir Michael Foster gives of the Galenic physiology.

The parts of the food absorbed from the alimentary canal were carried by the portal vein to the liver, and were there converted into blood, or rather the blood was there enriched with nutriment, or as it was termed "natural spirits." This crude blood, passed by the vena cava to the right side of the heart, and some of it filtered from the right ventricle through innumerable invisible pores in the septum into the left ventricle. As the heart expanded in its beat, it drew air from the lungs into the left ventricle. This mixture of blood and air by the help of the heat, which was innate in the heart, which was placed there as the source of the heat of the whole body by God in the beginning of life, and which remained there until death, was imbued with "vital spirits" while at the same time the innate heat of the heart itself was tempered and prevented from becoming excessive.

From the right side of the heart there was sent to the body generally along the great veins and also to the lungs a flow, followed by an ebb, of crude blood endued with natural spirits only, blood serving the lower stages of nutrition. From the left side of heart there took place also along the arteries to all parts of the

body a flow, followed by an ebb, of blood endued with vital spirits, and so capable of giving power to the several tissues to exercise their vital functions. It was the blood which the left heart sent to the lungs through the pulmonary veins which carried those fulginous vapors which, in the fermenting activity giving rise to the vital spirits, were extracted from the crude blood, and were finally discharged into the air in the lungs. The nutriment of the food which had been converted into natural spirits in the liver and transformed into vital spirits in the heart, finally reached the brain by way of the arterial blood and there generated the animal spirits, which, pure and unmixed with blood, were carried along the nerves to bring about muscular movements and other functions of the body.

All this sounds exceedingly crude in its conception of the heart and blood vessels, but it is still cruder in that which it omits, namely, in the lack of any conception of the energy liberating function, metabolism, the mechanism and meaning of respiration and the relation of the organism to the atmosphere. For all of this, as I have said, we have to wait until Lavoisier founded modern physiology less than 150 years ago.

It was not until near the middle of the 16th century that any one seemed to have grasped the true relation of the heart and lungs; then Michael Servetus, in a great theological work, with physiological illustrations, included a passage in which he announced that the blood, instead of filtering through the walls of the ventricles, is, on the contrary, pumped from the right heart to the lungs and, thus aerated and made bright by the passage, is sent into the left heart; there apparently he thought it stopped. It seems odd, almost humorous, that this physiological discovery should have been included in a work on theology, but humor gives place to thought when we recollect that Servetus was burnt at the stake for the religious views and doubtless also in part for the physiological views which his book contained; yet the beliefs of both sorts stated in that book were essentially what all educated people now hold; and the man who brought about his death was Calvin, the great founder of that movement in thought out of which to a large extent Puritan New England and Yale University took their origin. Evidently it is not always best even for very positive people introducing an important new idea to be too hasty in destroying those who differ with them.

Vesalius, the founder of anatomy, who also lived in the sixteenth century, thought it safer as regards the Galenic conception of the heart to speak as follows:

> The septum of the ventricles, composed as I have said of the thickest substance of the heart, abounds on both sides with little pits impressed in it. Of these pits, none, so far at least as can be perceived by the senses, penetrate through from the right into the left ventricle, so that we are driven to wonder at the handiwork of the Almighty by means of which the blood sweats from the right into the left ventricle through passages which escape human vision.

As a reward of this caution, Vesalius escaped serious persecution and died in his bed. Anatomists have always been a quieter, less restless sort of people, with less desire for revolution and changes in the curriculum than have the physiologists.

We come now to William Harvey. There is little need to describe Harvey's conception of the heart beat, for it is almost word for word contained in every textbook of physiology at the present time. In most points regarding the heart itself this clear, simpleminded, straightforward experimenter attained completeness and perfection. His book, "The Motion of the Heart and Blood in Animals" is the most delightfully readable of scientific works and, as a good English translation of its original Latin is purchaseable in the cheap but serviceable Everyman's Library, every student in any branch of biological science should own and read it. When Harvey is read first hand, it becomes clearer than any lecturer can explain that it was the lack of knowledge of what we now call energetics and metabolism, physics and chemistry, and the real meaning of respiration which gave to his path its peculiar difficulty and limited his discovery. It is his merit that in the midst of the misconceptions of these matters which he could not and did not correct, he attained truth for his own special topic, the mechanism and meaning of the heart movements. He says:

> When I first gave my mind to vivisections, as a means of discovering the motions and uses of the heart, and sought to discover these from actual inspection, and not from the writings of others, I found the task so truly arduous, so full of difficulties, that I was almost tempted to think with Fracastorius that the motion of the heart was to be comprehended only by God. For I could neither rightly perceive at first when the systole and when the diastole took place, nor when and where dilatation and contraction occurred, by reason of the rapidity of the motion, which in many animals is accomplished in the twinkling of an eye, coming and going like a flash of lightning; so that the systole presented itself to me now from this point, now from that; the diastole the same; and then everything was reversed, the motions occurring, as it seemed, variously and confusedly together.

His most difficult task, as is often the case in a discovery of the first rank, was to refute the errors and misconceptions of the time, and to free his readers from false modes of thought. He says:

> Almost all anatomists, physicians, and philosophers, up to the present time, have supposed with Galen, that the object of the pulse was the same as that of respiration; that is, to cool the blood. But did the arterial pulse and

the respiration serve the same ends; did the arteries in their diastole take air into their cavities, as commonly stated, and in their systole emit fuliginous vapors by the same pores of the flesh and skin; and further did they in the time intermediate between the diastole and the systole, contain air, and at all times either air, or spirits, or fuliginous vapors, what should then be said of Galen's experiment showing that the arteries contain blood?

Having thus given his reasons for believing that the heart performs some function other than that of the chest and lungs in breathing, he proceeds to give the following description, the classic account of the heart beat:

At the moment the heart contracts, and when the breast is struck, when in short the organ is in its state of systole, the arteries are dilated, yield a pulse and are in the state of diastole. . . . The arteries, therefore, are distended, because they are filled like sacks or bladders, and not because they expand like bellows. It is in virtue of one and the same cause, therefore, that all the arteries of the body pulsate, namely, the contraction of the left ventricle; in the same way as the pulmonary artery pulsates by the contraction of the right ventricle.

All the points which these quotations assert were demonstrated by Harvey by numerous experiments and keen observations on living animals, on frogs, snakes, pigeons, fish, dogs and so on and also by experiments and observations on the veins in the arms of man.

Few figures in science stand out as originative and creative as Harvey and yet he has been criticized from two almost directly opposite standpoints. The points made are true but do not really decrease his merit. It has been shown on the one hand that the greater part of what Harvey wrote had been thought and suggested by others previously more or less clearly and that he got the germ and possibly even some of the form of his ideas when a student in Italy, for the Italian universities were at that time the living centers of thought in Europe. On the other hand, it has also been shown, particularly by the late Professor J. G. Curtis, who was profoundly versed in the physiology of the Greeks and Romans, that to a considerable extent Harvey himself was as much in the dark regarding the uses of the circulation as any of his contemporaries, and that he fell back upon Aristotle just as they did. Here he gropes and stumbles and fails; and as Curtis shows, the circulation in Harvey's mind apart from the physical movements of the heart was more Greek than modern. It had in it more of Aristotle than of Carl Ludwig.

There is no doubt that there is truth in both these comments upon Harvey. He drew on the knowledge contained in the literature of his time and was hindered or helped by what it lacked or contained just as we are now. It puts such matters in their true

light, however, to notice that the same sort of comments apply to nearly all the great discoverers; for instance, in the case of Christopher Columbus, it has been shown, I believe, both that others had discovered America before him and also that Columbus did not realize that he was discovering America. Neither Columbus nor Harvey nor any other great discoverer can possibly realize the enormous consequences which will grow out of his work, but this fact does not in the least decrease their greatness and the immensity of our debt to them.

Even with all the resources of modern laboratories, the problem of just how much blood the heart discharges at each beat is not yet solved much beyond the point at which Harvey left it.

In Harvey's day or shortly afterward, there lived in Italy two great physiologists, Malpighi and Borelli: intimate friends at first, but later disagreeing, Borelli vented his feelings on his colleague's scientific work in quite modern fashion. Malpighi was chiefly a great anatomist, and especially a histologist and as such his work has been described in a preceding lecture of this series, but he has this supreme interest for us that he was the first to turn the microscope upon the finer blood vessels of the circulation and thus to see the marvelous picture of the blood pulsating in arterioles, its corpuscles squeezing through capillaries, to be reassembled in the central column of the slow and steady stream of the venules. It is most significant that this discovery depended upon the use of the then new physical instrument of precision, the microscope.

Borelli was one of the first to accept Harvey's teaching and he explained more fully than Harvey had done the mechanics of the pulse. He recognized the part which the elasticity of the arteries plays in converting the intermittent discharge of the heart into a steady flow and first expressed the idea of the peripheral resistance of the circulation. Here again we find the association of physics and physiology. As a student Borelli had studied the writings and for a time had listened to the lectures of Galileo, the man who first recognized that the world revolves about the sun and who defined gravity and other physical conceptions. Borelli had associated with and been influenced also by Torricelli, to whom we owe our modern conceptions of atmospheric pressure and of the nature of a vacuum and the barometer.

It was in such an atmosphere that Borelli worked; a mathematician, a physicist and a physiologist. His greatest work was on animal motion. He treated the bones as levers and the muscles as motors and worked out correctly many of the mechanical movements of the body and limbs, as well as of the viscera. Much of what he said is as true to-day as it was when he wrote it. He also

dealt the death blow to that idea of a "spiritus" or air, which was supposed to be blown by the brain through the nerves, then believed to be minute tubes, to the muscles, inflating them and thus causing their contraction. His crucial experiment, which, as he expressed it, "does away with all this nonsense about spiritus" he describes thus:

> When the muscles of a living animal are divided lengthwise, while the animal is submerged under water, and in consequence of the pain is struggling violently, in the midst of such great copious fervor and ebullition of the supposed spirituous gas which would thereby be excited in the muscles, one would expect that innumerable bubbles of gas would burst forth from the wound, and ascend through the water; whereas nothing of the kind takes place.

You will all recognize the soundness of this experimental method of locating an air leak.

About the time that Borelli died in Italy, another remarkable man was born to carry on his work. Born in England, Stephen Hales was a younger son of an English country gentleman and, as was the custom of younger sons, he turned to the church for a living. He studied at Cambridge and obtained a B.A., M.A., and B.D. and later, from Oxford, an honorary D.D. In college he did many dissections and repeated the experiments, the scientific novelties of that day, by which Boyle had been led to the gas law which bears his name. Later Hales lived the life of an active country clergyman, but he seems to have thought the glory of God was best demonstrated by revealing the wonders of nature, for few scientific men of that time have as long or as valuable a list of experimental investigations as has Hales. He died in his 83rd year and his monument is in Westminster Abbey; in fact, he was a very eminent man. He was extraordinarily modern minded, for in practically all his work he used accurate quantitative methods and his employment of the word "equilibrium" in the following definition of health would be creditable in 1922. He says:

> As the healthy state of the animal principally consists in the maintaining of a due equilibrium between the fluids and solids, it has ever since the important discovery of the circulation of the blood been looked upon as a matter well worth inquiring into to find the force and velocity with which these fluids are impelled; as a likely means to give considerable insight into the animal economy.

Accordingly, he performed the celebrated experiment which bears his name and which he describes as follows:

> In December I caused a mare to be tied down alive on her back; she was 14 hands high and about 14 years of age; had a fistula on her withers; was neither very lean nor yet lusty; having laid open the left crural artery about three inches from her belly, I inserted into it a brass pipe whose bore was one-sixth of an inch in diameter; and to that, by means of another brass

pipe which was fitly adapted to it, I fixed a glass tube, of nearly the same diameter which was nine feet in length; then untying the ligature on the artery, the blood rose in the tube eight feet, three inches perpendicular above the left ventricle of the heart . . . . . when it was at its full height, it would rise and fall at and after each pulse two, three, or four inches. . . .

This was the first accurate measurement of arterial pressure.

Thus far we have talked mainly of the circulation because in this brief summary of the history of physiology, we are omitting mere chronicles of false and misleading ideas and are selecting as the origins of our science those ideas only which were and are true or which have led to truth. Under this rule, there is little to say of the chemical side of physiology down through Greek, Roman, and medieval times. The alchemists were as furtive as our forgers, for alchemy was a crime close to witchcraft, an offence for which one was burnt at the stake. Thus when that amazing figure, Theophrastus Bombast von Hohenheim, also called Phillipus Aurelius, and commonly known as Paracelsus, who is said to be the original of Goethe's Faust, first introduced chemistry to physiology, along with opium, hydrochloric acid and other new drugs and chemicals, he also brought the mystical idea that over each reaction presides an archeus, a "spirit called from the vasty deep" to control it. From these Archei our digestive and other ferments are descended, and perhaps the vitamines belong in the same family. It is difficult to find an easily quotable passage to give an idea of what an Archeus was in the mind of an alchemist facing a problem in biochemistry. But a great modern thinker and writer who was also a thoroughly medievally minded man, the late Cardinal Newman, has expressed essentially the same idea in these wonderful words:

He is speaking of his opinions of angels and he says:

I viewed them not only as the ministers employed by the Creator in the Jewish and Christian dispensations, as we find on the face of Scripture, but as carrying on as Scripture also implies the economy of the visible world. I considered them as the real causes of motion, light and life, and of those elementary principles of the physical universe, which, when offered in their developments to our senses suggest to us the notion of cause and effect, and of what are called the laws of nature. . . . . What would be the thoughts of a man who when examining a flower or a herb or a pebble or a ray of light, which he treats as something so beneath him in the scale of existence, suddenly discovered that he was in the presence of some powerful Being, who was hidden behind the visible things he was inspecting, who, though concealing his wise hand, was giving them their beauty, grace and perfection, as being God's instrument for the purpose, nay, whose robe and ornaments those objects were, which he was so eager to analyze. . . . . Every breath of air and light and heat, every beautiful prospect, is, as it were, the skirts of their garments, the waving of the robes of those whose faces see God.

As a further illustration, I am reminded of some words of St. Augustine which I came across in his Confessions not long ago and which show the medieval attitude toward scientific investigation. He was discussing the nature of time. Time, he said, may be measured as the duration needed to read a certain number of verses, or to walk a certain distance. What will be its end, he asks. Obviously the Judgment Day. What was its beginning? Obviously the morning of the first day of creation. But what, he asks finally, was God doing before the creation? And he answers by saying that, according to the best authorities, God was then engaged in preparing Hell for those who inquire too closely into his mysteries.

Following Paracelsus came von Helmont who was half modern and half medieval. He invented the word gas and to a considerable extent the conception for which it stands: an enormous service, for he described correctly to a great extent the formation of carbon dioxide in the fermentation of grapes, from which idea, as you will see, by slow gradations has come our idea of respiration. Of gastric digestion he said: "If the ferment were only an acid, vinegar alone would be able to transmute a mass of bread and be sufficient for the transformation of all our food." A ferment he described as "a specific gift of vital nature." He says also that the acid chyle passing from the stomach into the duodenum immediately acquires a saline nature, and changes from an acid into a salt, "just as vinegar by the addition of nimium (lead oxide) is changed into an aluminous sweetness." In the intestine a further change in the food materials is brought about, as he expressed it, "through a more excellent vigor of transmutation." He still believed in the Archeus, a sensitive soul, as the controlling agent in all bodily acts; but he was sufficiently modern to try to determine the location of the soul by experimental methods. Thus he made the seat of the Archeus not the brain, but the pylorus of the stomach; and for this he gives three reasons: first, a great emotion is always felt in the stomach; second, a man's head may be blown off by a cannon ball and his heart continues to beat for a short time; but third, his heart is instantly stopped by a blow in the stomach.

Following von Helmont in the next generation, Francois duBois or Sylvius discarded the Archeus and expelled spiritualism from biochemistry. Like a modern biochemist he held that if we had complete knowledge of the chemical reactions between acids and alkalis, life itself would be explained. But he also made just the sort of mistake that a modern biochemist knowing much chemistry and little biology makes: he saw gas bubbles rise in fermenting

dough and also in a vessel into which he had put carbonate of lime and hydrochloric acid, so he inferred that the chemistry of the two processes was identical. Sylvius assigned great importance in digestion to saliva, and one of his pupils, DeGraaf, among other important work, was the first to insert a cannula in the duct of Wirsung and to collect pancreatic juice. Both Sylvius and De. Graaf held that the juice was acid.

Space prevents my telling of the contributions and ideas of Stahl, Boerhaave and the great Haller who wrote a text-book of physiology in eight large volumes in Latin. One of the most co. crete experimental additions to our knoweldge of digestion dating from this time was made by Réaumur. He fed a kite, a sort of hawk, with metal tubes with wire nettings over their ends containing meat. When the kite, according to its habit, regurgitated the tubes from its stomach, Réaumur noted that the meat had been dissolved out. The diet proved, however, too much for the kite, and its death ensued. Réaumur then carried on the same sort of experiments on dogs, showing the solvent action of gastric juice, which he was the first to obtain by placing pieces of sponge in the little metal tubes which he gave his animals to swallow, and which he obtained again from their stomachs.

Réaumur's line of experimentation was later continued with much industry and ingenuity by Spallanzani in Italy. But the extent of the knowledge gained is shown by the report which Spallanzani obtained from one of his colleagues, the professor of chemistry, who analyzed for him a sample of gastric juice. The chemist reported that "the fluid contains first pure water, secondly a saponaceous and gelatinous animal substance, thirdly salammoniac, and fourthly an earthy matter like that which exists in all animal fluids. It precipitates silver from nitrous acid and forms luna cornea. This phenomenon might induce us to suppose that common salt exists in the gastric juice; but the salt contained in this fluid is not common salt but salammoniac."

Now we approach the nodal point where the major lines of chemistry, physiology and physics unite to radiate again into the broad field of modern science. At the very center of the node we find Lavoisier. But first a few words of the men whose work he interpreted.

For the chemist the problem was the nature of combustion; for the physicist, it was the origin of the heat and power liberated; for the physiologist, it was the meaning of respiration and the source and mode of the heat and power of the living body. That respiration was the very essence of life even the Greeks fully realized, but they had scarcely any conception of the physical character

of a gas or the chemical differences between various gases. But let us be modest in our knowledge, for among the students of to-day an easy comprehension of the nature of gases and their laws is so rare as to be almost a special gift.

It was Robert Boyle who in 1660 took the first great step by showing by means of the air pump that in a vacuum a candle is extinguished and a mouse or sparrow dies. Seven years later Robert Hooke showed that it is not the movements of the chest which maintain life, but the passage of air through the lungs, for after opening the thorax of a dog, and making a number of small holes in the lungs for the air to escape through, he blew a constant strong current of air into the trachea, and life was maintained. At nearly the same time Lower demonstrated that it is the aeration of the blood in the lungs which causes the change of color from the dark maroon of venous to the bright scarlet of arterial blood, and he even sensed the relation of respiration to combustion, for he says of the need of fresh air, "were it not for this, we should breathe as easily in the most filthy prison as among the most delightful pastures"; and again he says: "where a fire burns readily, there can we breathe easily." Lower was an Oxford man.

So also was Mayow, whose attention was caught by the part which nitre plays in giving to gunpowder its power. Following this lead through ingenious experiments, he came to the conclusion "that this air which surrounds us, and which since by its tenuity it escapes the sharpness of our eyes, seems to those who think about it to be an empty space, is impregnated with a certain universal salt, of a nitro-saline nature, that is to say with a vital, fiery, and in the highest degree fermentative spirit." This of course was oxygen. He recognized that burning and breathing were essentially identical and that the part of air essential to life is absorbed by the blood as it passes through the lungs. He almost sensed the nature of carbon dioxide also. But Mayow, Boyle, Lower and Hooke died and left no successors. The great Oxford school of physiology ceased for nearly 200 years, to be revived brilliantly by Haldane in this same field of respiration in our own day.

In the years following the English school, George Ernest Stahl, working at Weimar, Halle and Berlin, and making indeed valuable contributions, yet did more harm than good by his celebrated theory of phlogiston. He defined phlogiston as the essence of fire, for he conceived fire as a material thing. When any substance was burned, such as a piece of carbon, or when a metal was oxidized, the process was considered by Stahl to consist in the escape of phlogiston. When an oxide was reduced, phlogiston was, he thought, imparted to the metal. Thus physically phlogiston was a

sort of pseudo energy; chemically it was the antithesis of oxygen. This was altogether the most harmful error that has ever occurred in science. It utterly obscured the chemistry and energetics of respiration.

About the middle of the 18th century, Joseph Black, professor of chemistry at Edinburgh, identified what he called "fixed air," and which as he found comes off when limestone is calcined, in other words, carbon dioxide. He also showed that this fixed air is produced by fermentation, by burning charcoal, and that it is given off in the air expired from the lungs. He identified it in each case by the precipitate, or white cloud, which "fixed air" produces when blown through lime water.

About this time also Joseph Priestley first prepared oxygen. He had early found that air made irrespirable by burning a candle in it could be made again respirable by growing a green plant in it. In 1774 he made oxygen gas by heating oxide of mercury and showed its properties; but he was unable to free his mind from the phlogiston theory. He called breathable air "dephlogisticated air" and air rendered irrespirable by burning a candle in it he called "phlogisticated air." So, too, venous blood he considered to be blood laden with phlogiston which it gave off in the lungs where it came in contact with dephlogisticated air. His whole conception of combustion and of respiration was thus a completely inverted image of the truth.

Meanwhile Scheele, a struggling apothecary but a man of genius, in Sweden, was doing independently the same type of experiments, and expressed his conception of respiration in the suggestion that "the blood and lungs change fire air into acid air."

Now we come to Lavoisier, a master figure in three sciences: chemistry, physiology and physics.

Lavoisier was a rich tax collector for the French government and as such was connected with the Treasury. Gold is the one thing in respect to which weighing with fine balances is most important, and the association of Lavoisier through tax collecting with the art of weighing accurately was probably of critical importance in guiding his genius. Through the inherent intuitional power of his mind he assumed as no one else had done, and he proved, that matter can neither be produced nor destroyed as it passes from one form to another and that the one chemical property which is indestructible is its weight. He found that a reaction occurring inside a closed glass vessel involves no change of weight, and, as he said, "the usefullness and accuracy of chemistry depend entirely upon the determination of the weights of the ingredients and products both before and after the experiment."

Thus he established the major principle of modern chemistry. With his associate, LaPlace, he also constructed an ice calorimeter and determined the amount of ice which was melted when a given amount of carbonaceous material was burned in it. Thus for physics he laid the cornerstone of thermo-dynamics. For physiology he revealed the association of respiration and animal heat, for he put a guinea pig into the ice calorimeter and found that it produced 224 grams of "fixed air" (carbon dioxide) while melting 13 ounces of ice, and that these figures agreed fairly closely with those obtained when carbonaceous material was burned. At the same time he found that the animal consumed an amount of "eminently respirable air" or "air pur" (that is oxygen) such that the respiratory quotient (carbon dioxide exhaled divided by oxygen consumed) was 0.84. Thus he made a long step toward the idea of the conservation of energy as well as the nature of animal heat; and the meaning of respiration was revealed.

Lavoisier freed chemistry and physics from the phlogiston theory; he showed the real nature of oxygen, to which he gave its name, and the part it plays in combustion. His crowning experiment was a complete determination of respiratory metabolism upon man with and without food and during various amounts of work, which he found involved a fourfold increase in the consumption of oxygen above that in the resting condition. His reflection on this is interesting, for he said:

> This kind of observations suggests a comparison of forces concerning which no other report exists. One can learn, for example, how many pounds of weight lifting correspond to the effort of one who reads aloud, or of a musician who plays a musical instrument. One might even value in mechanistic terms the work of a philosopher who thinks, the man of letters who writes, the musician who composes. These factors which have been considered purely moral have something of the physical and material which this report allows us to compare with the activities of the man who labors with his hands.

What he would have done had his life not been cut short may be gathered from the following passage, the conclusion of his last communication to the Academy:

> Up to the present time we have learned only to conjecture as to the cause of a great number of diseases and as to the meanings of their cure. . . . Before hazarding a theory we propose to multiply our observations, to investigate the phenomenon of digestion, and to analyze the blood both in health and disease. We will draw upon medical records and the light and experience of learned physicians who are our contemporaries, and it will be only when we are thus completely armed that we will dare attack a revered and antique colossus of prejudice and of error.

But the storm clouds of the French Revolution were gathering. Then as now, as always, after war and revolution, the scientific

man who dares to think for himself is the inevitable victim of another type of man, the type of Marat, vulgar, aggressive, intolerant, the self-appointed agent of the new thing whether in government or in education. Lavoisier was sent to the guillotine. Doubtless always on great stages and on small, when the Marat type succeeds in grasping power for the short time that such men can be tolerated, their instinctive and first act will be to destroy those who guide their steps by a love of honor and of truth.

Were physiology merely biochemistry and biophysics, here I might stop. But there is yet another name which, although it came in the nineteenth century, stands out so preeminently as neither merely biochemist nor biophysicist but as a physiologist par excellence, that I must say in closing a few words about him—Claude Bernard.

With methods as simple for the most part as those available in the centuries preceding him, he revealed to us the vasomotor nervous system, the glycogenic function of the liver, the regulation of animal heat—the nature of carbon monoxide asphyxia—to mention only a few of the greatest of his achievements. It is not, however, to these particular discoveries that I wish to point attention, but rather to a general idea which is in danger of being lost sight of nowadays in the enthusiasm for the solution of the problems of mechanism.

It is to Claude Bernard that we owe particularly the conception of regulation: the organism as a dynamic equilibrium, the organism as a whole, the organism in control of its environment. It is in such lines of thought, originating with Aristotle and coming down through DesCartes, that physiology as physiology must be carried on by physiologists after biochemistry and biophysics have established themselves as sciences in their own right. Theirs are the problems of mechanism in the narrower sense, for physiology there remains the more general problem of living creatures as a whole and the coordination of their organs. It will be the service of biochemists and biophysicists to show, as Aristotle said, how "this and that part of a process (chemical or physical) is necessitated by this or that other stage of it." It is for physiology proper to study what Hippocrates called "physis," and as Aristotle also said "to show that this and that process takes place for such and such a final object."

This is not vitalism. It is organicism. In biology a mechanist is like a mechanic whose attention is fixed on wheels and valves and bolts. A physiologist must not be like such a mechanic, but rather like an engineer who views the organism as a whole, both in the interplay of its parts, its integration, and in its exterior relations.

the organism in its environment. This is a field in which we can not perhaps expect for centuries still to come to attain wholly chemical and physical explanations. Three great examples in the recent development of such physiology occur to me: Pawlow's "Work of the Digestive Glands," Sherrington's "Integrative Action of the Nervous System," and Haldane's "Respiration." Each is founded on the best physics and chemistry available, but each goes far beyond the physics and chemistry of the present day in showing correlation and regulation.

This conception of physiology was defined by Claude Bernard as a study of the body's capacity to "preserve constant the conditions of life in the internal environment. It is a conception which has been termed organicism. It prompts us to the most thorough analysis of which biochemistry and biophysics are capable into the problems of mechanism, but it looks on this analysis as a mere preliminary and sees as the essential topic of the physiologist those living reactions and processes by which (expanding Claude Bernard's statement) "the organism preserves constant" or rather adjusts, controls and regulates within narrow limits of variation, such "conditions of life" as osmotic pressure, hydrogen ion concentration, temperature, content of sugar, calcium and potassium, and a thousand other elements already known, suspected, or yet to be discovered "in the internal environment."

THE STRENGTH OF THE CHIMPANZEE AND ORANG

By JOHN E. BAUMAN
ALLENTOWN, PA.

THE writer had so often noticed that, while all authorities on the anthropoid apes judged them to be greatly the superior of the human being in strength, no exact tests of their strength were cited, so that it seemed to him that even a few definite strength tests would be of interest and value.

Accordingly he made an attempt to obtain such tests by the use of a dynamometer used for testing the back and leg strengths of college students for anthropometric records.

The difficulty in getting the apes to make a fair test of their strength was found to be great. In the first place, the apes showed fear of the glisten of the metal of the apparatus which deterred them till they got used to the latter and found it harmless. In the second place, after the anthropoids had thus got used to the apparatus they quickly lost interest in it.

There thus proved to be but a few hours' interval in which tests of any value could be obtained. By attaching ropes to the apparatus, there was no difficulty in getting the apes to pull, but they would pull cautiously to see if the apparatus was loose, and when they found it firm they would stop pulling long before their maximum effort had been reached. Endeavors to tempt the apes into a maximum pull by having a man hold the rope, with the idea that the anthropoids would try to pull it out of his hand, did not accomplish what was desired, since the apes let go, or at least ceased pulling strongly, as soon as the man loosed his hold on the rope. The apes likewise had a tendency to try and jerk the rope instead of making a strong smooth pull. These jerks looked vigorous, but the dial of the recording device showed records of only one hundred to two hundred pounds.

Unexpected good fortune, however, attended the first trial with "Sister Suzie" Suzette, a highly trained adult female chimpanzee who formerly was a circus attraction, being a good bicycle rider and an adept at roller skating. She has recently attracted some notice because of her being the only chimpanzee to have had two "children" born to her while in captivity, Boma being the father. Both of these infants died within a few weeks.

CHIMPANZEE "SUZETTE"
With arms shaven for state performances before her entry into the New York Zoological Fark.

The increasing treacherousness and meanness of Suzette's disposition was the factor that finally compelled her owner to retire her from circus life and place her in the New York Zoological Park, where the strength tests in question were made.

It is interesting to observe that it was Suzette's tricky and malicious disposition which caused the first test with her to be a complete success. As the writer had just finished fastening the chain that held the opposite end of the apparatus firmly to the steel frame several feet in front of the cage, Suzette, evidently fancying that she had the handlers of the apparatus at a disadvantage and could pull it to pieces, sprang at the rope and, bracing both feet against the bars, pulled back with both hands upon the rope, making a pull on the latter that recorded 1,260 pounds upon the dial of the recording device.

The viciousness of this pull was something remarkable, and in strong contrast to the half-hearted attempts of the orang tested just before this, as well as of Suzette's own subsequent attempts after she had learned that she could not tear the apparatus loose or smash it. Everything about the manner of the pull, as well as the set of the muscles of the ape's body and face, indicated a pull of maximum intensity. After the first pull Suzette refused to really exert herself, although she made one two-hand pull of 580 pounds without appearing to make a noticeable effort. She also made a number of jerks and moderate pulls ranging from one hundred to two and three hundred pounds.

A point of interest in interpreting Suzette's greatest effort lies in the fact that she had both legs considerably bent at the knee, so that a muscular effort, to keep them from bending farther, of 1,260 pounds must have been made during the maximum of the pull. It has often been estimated that from the waist down the chimpanzee is hardly superior to the human being. According to the tape-measure, this would seem to be true, but the recording device tells another story. To the fingers the anthropoid's thigh muscles feel if anything firmer than the back muscles.

An average college student of Suzette's weight, 135 pounds, can pull in an approximately similar position and manner but 332 pounds, while one out of every hundred students can thus pull 500 pounds. Therefore Suzette's superiority on the basis of weight is in the ratio of more than three to one, while it would be an exceptional college student of any weight whose record she could not easily double.

Judging from appearances, the strength of the arms and shoulders of Suzette must be still more superior to that of the human being than is that of her back and legs. She made a few

CHIMPANZEE SUZETTE AT THE NEW YORK ZOOLOGICAL PARK

GIANT CITAN OF THE NEW YORK ZOOLOGICAL PARK

approximately one hundred pound pulls, or rather jerks, with her teeth on the rope, and the writer hoped to get some data on the strength of her massive neck, but she would not make a fair test; in fact, had she tried she would almost certainly have cut the rope to pieces with the grip of her teeth.

No tests of any kind could be made upon Fanny, another female chimpanzee, for she refused to have anything to do with the apparatus.

Boma, said to be the largest chimpanzee at present in captivity and whose weight is estimated at 165 pounds, is such a splendid specimen of muscular development that it was disappointing not to be able to coax him into a two-handed pull by hook or crook.

A good one-hand pull which certainly closely approached his maximum was secured. During this pull the ape braced both feet on the floor of the cage and held on to a door leading into the next cage with his left hand while he pulled back upon the rope with his right as hard as he could, all his bodily and facial muscles testifying to the effort being made, although the sharp viciousness of Suzette's maximum effort was not in evidence in the manner of making the pull.

The recording device showed a pull of 847 pounds. After this tremendous pull, the ape made a 640 pound right hand pull without showing a very noticeable effort, and later several pulls ranging from 450 pounds to 200 pounds, which seemed quite easy for him. After this he lost interest and would make no further pulls. (In connection with the above the question suggests itself, what could a 450 pound gorilla do?)

It is worthy of note that in all his pulls except the lightest, Boma used the right hand in preference to the left. Under ordinary circumstances the writer has observed that, although to a certain extent ambidextrous, both the orangs and the chimpanzees when they wish to make an exceptional effort use the right hand in preference to the left.

It would be interesting to learn whether an adult male chimpanzee or orang could tear the scalp by seizing a human being by the hair as depicted in Edgar Allan Poe's imaginary account in the "Murders in the Rue Morgue." The writer always in the past regarded this feat as a grotesquely impossible figment of Poe's imagination, but an eight hundred pound pull is certainly a pretty strong one and it is possible that under such a strain the scalp might tear.

No results could be obtained with a young female orang, "Windy," and only two 140 pound one-hand pulls from the young 95 pound male orang "Dempsey," a result which no one who like

the writer has tried to pull a strap out of Dempsey's clutch and been hauled up against the bars by his slender sinewy arms will believe is his maximum strength of pull. In this connection it is worthy of note that the strength the orang and chimpanzee can exert is far greater than their girth of muscle or the latter's firmness would lead one to expect.

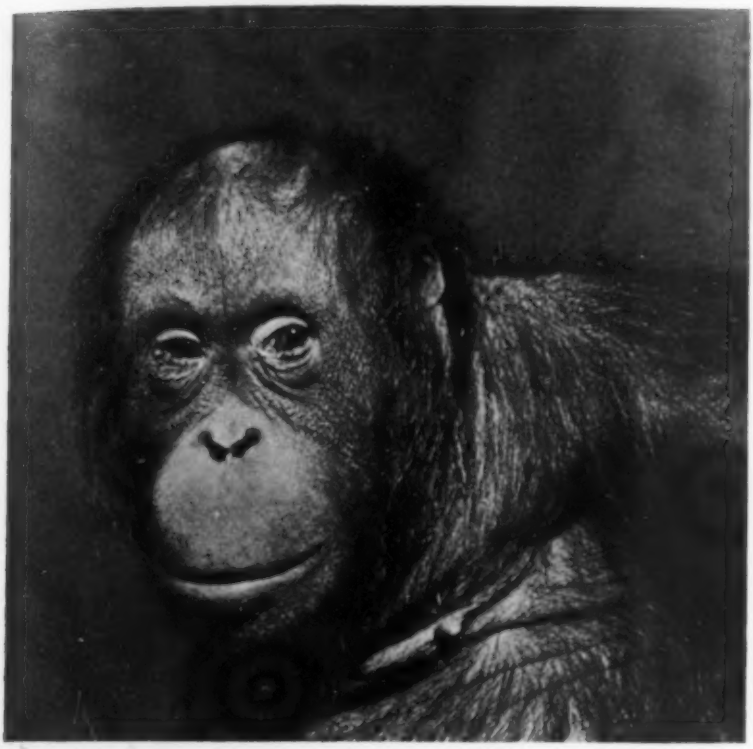
Only one attempt at hand grip tests was successful, and this recorded 64 kilos for Dempsey's right hand and several following attempts of 55, 35 and 25 kilos, respectively. Sixty-five kilos would be equal to that of a fairly strong man and may approach Dempsey's maximum, although the writer from his experience of Dempsey's clutch on his own wrist is inclined to believe this sinewy, lovable little orang could do better than 65 kilos on occasion. Boma's hand is so broad and mighty that his power of grip must be something tremendous, but no way of making a test was evident, since even if he could have been induced to hold the hand-grip dynamometer properly, Boma would even in a light effort unquestionably have surpassed the capacity of the apparatus, whose maximum reading is 100 kilos, the dial being graduated according to the metric system.

In closing this account, the writer wishes to take this opportunity to heartily thank the director of the New York Zoological Park, Dr. W. T. Hornaday, the veterinary of the Garden, Dr. W. Reid Blair, and the keepers of the primate house, Messrs. Palmer and Rawlinson, for their kindness in making possible the above tests and their invaluable aid in carrying them out.

Also hearty thanks are due to the authorities of Muhlenberg College for the loan of the pull test apparatus, and to those of Lehigh University, the second Alma Mater of the writer, for the loan of the hand-grip dynamometer used in the foregoing tests.

The writer would like to suggest that if any one desires to make further investigations in strength tests, the best results will in his opinion be secured with specially constructed apparatus which will have a dull finish so as not to remind the apes of the glisten of a revolver, of which latter they are ludicrously afraid. Such apparatus, to secure the best results, should have a powerful steel spring which can hold the ape's greatest possible pull and yet give just enough to make the anthropoid think that something is yielding and that it is worth while for him to pull to the limit of his capacity because it feels as though something might tear if he only pulls hard enough.

Further, large-sized rings like the well-known "flying rings" of the gymnasium or even larger would be apt to prove a very much better means of securing a maximum two-hand pull than the wooden handle, which the writer was forced to discard because



FACE OF THE ORANG-UTAN

of its getting twisted up in the bars by the apes not holding it properly or than the simple looped rope on which he later relied.

The recording apparatus had better be concealed from the anthropoid's view, since it often seriously distracts his attention from the pull. The rope to which the ring is attached should be just long enough for the ape to stand behind the bars and brace against them with his feet; if it be longer than this he either lacks purchase or pulls sideways with loss of power where the rope bends around the bar.

A hand-grip dynamometer should be a simple oval ring, with the recording device boxed in under cover of glass or celluloid, and a chain attached to one side of the ring, so that when the ape clutches the latter firmly to prevent the testers from pulling it out of his hand by the attached chain, the exact position of the ring in his hand will be immaterial and he can not tamper with the recording device.

WILHELM KONRAD VON ROENTGEN

Whose death is announced from Munich. Professor Roentgen's discovery of the Roentgen or X-rays in 1895 began a new era in the development of the physical sciences.

THE PROGRESS OF SCIENCE

CURRENT COMMENT

By Dr. Edwin E. Slosson
Science Service, Washington

JOB WANTED FOR FURFURAL

A new material has come into the market and wants to make itself useful if any one can show it how. Its name is "furfural"; queer sounding, but not so hard to pronounce as most chemical terms. The public is lucky to be let off with only three syllables and those slipping easily off the tongue.

Two years ago furfural was selling at $30 a pound. Or rather this was the price it was quoted at in lists of rare chemicals. Really it was not selling at all, except when a professor wanted a little vial of it to put into his museum case of organic preparations.

But it is now known that the stuff can be made cheaply from materials that are going to waste in unlimited amounts, such as corn cobs, oat hulls, straw and the like. Consequently, furfural is now quoted at twenty-five cents a pound and could be made very much cheaper, perhaps six cents a pound in a large scale plant, one capable of taking in, say, a hundred tons of cobs a day and turning out six tons of furfural. All that is needed is to cook up the cobs with steam.

I saw it done at the Color Laboratory of the Department of Agriculture, on the Arlington Farm, just across the Potomac River from Washington. A large steel still was set up in the center of the big building. Two bags of corn cobs were dumped into the cylinder; then the top was screwed on and the steam turned in. After digesting for a couple of hours the furfural was distilled in a stream of steam, and the water and furfural condensed together by cooling. This mixture is afterwards separated by redistillation.

Furfural is a liquid, clear and colorless as water when fresh and pure, but turning brown when exposed to light and air. It takes fire easily and burns with a bright flame. It has a characteristic odor, but not strong or unpleasant. It is what the chemists call a "ring compound," for its molecule is composed of four carbon and one hydrogen atoms, connected in a ring with an extra atom of carbon and another of oxygen and four hydrogen atoms attached outside.

But we are all more interested in what furfural can do than what it is. This, however, remains to be found out. The first thing that we think of is using it as a motor fuel, since a shortage of gasoline is impending. Furfural can run a car, but does not seem to be suited to the ordinary type of motor and anyhow it is still twice as high as gasoline and therefore out of reach.

Furfural is poisonous to insects and germs. Perhaps it could find employment here. It will dissolve paint and varnish, also fats and airplane dope.

More promising yet are its compounds. Furfural will combine with various coal tar products such as aniline and carbolic acid. With aniline and the like, it makes dyes of a variety of colors, but those so far made are fugitive.

With carbolic acid, furfural combines to form resins very much like bakelite, which is made from carbolic acid and formalin. These may be used in liquid form for varnishes or in solid form as insulation in electrical apparatus. We may expect furfural some day to appear in dis-

EDWARD JENNER

The centenary of whose death was celebrated on January 23. The illustration is from a bronze statue by Monteverde in the Museum of the Royal Society, London.

EDWARD JENNER
Showing the vaccination of his first patient in 1796. From the painting by Mélingue.

guise as amber beads or tortoise shell combs or ivory billiard balls or horn buttons. Phonograph records may be made from it, also plates for printing from instead of type. They are light, hard and tough.

In short, furfural is now in the position of a high-school graduate whom the principal claps on the shoulder and says: "You are a bright, versatile fellow. There is a great future before you." But when the boy asks, "Where?", he gets no answer.

This newcomer is knocking at the factory door with no credentials but a letter of introduction from the chemist which does not go far in the factory. The busy manufacturer turns to him long enough to ask: "Can you do anything better than those I've got or do it cheaper?" The applicant can only answer: "I don't know, sir. I think so, but I've never had a chance to show what I can do yet. Won't you give me a try-out?"

I can't give the answer of the

business man because I don't know what it is.

THE SILKWORM'S RIVAL

MAN has entered into active competition with the silkworm and, although the worm has the advantage of several million generations of previous practice in the art of silk making, man is rapidly catching up. The output of artificial silk has increased fivefold during the last twenty years, while the output of natural silk has only gained fifty per cent. More than a third of what seems silk to the eye comes from the factory instead of the cocoon. Some forty million foreign feet are now encased in synthetic silk stockings made in America.

Artificial silk is not silk and should never be sold as such. But if it is, it is not so much because the salesman desires to deceive, as it is because the public is unwilling to credit the chemist with the creation of something new or to believe that he can make anything so good as is made by a worm. Of late this unnatural prejudice in favor of nature is being overcome and the new synthetic fibers are being marketed by their manufacturers as they should be under synthetic names. Some of the trade names are viscose, lustron, fibersilk, lustre-fibre, Givet silk, Soie de Paris, Glanzstoff, artiseta, lustracellose. There are a lot of others, but I omit to mention them because I can't remember them.

There are four different modes of manufacture but the raw material is essentially the same, cellulose. This is the substance of wood, paper and cotton, so it is cheap and abundant enough, but the difficulty is to dissolve it so it can be squirted out of the tiny holes in the spinnerette to form the fibers. Water will not dissolve paper pulp, of course, nor will any ordinary solvent except strong acids and alkalies.

The first person to solve the problem was a Frenchman, Count de Chardonnet, who in 1884 deposited with the French Academy of Sciences a sealed document. Three years later this was opened and found to contain a method of making artificial fiber by treating cellulose with nitric acid. The resulting compound, which is a mild form of gun-cotton, can be dissolved in alcohol and ether, like the common collodion that we use to cover our skinned knuckles. But the nitric had to be thoroughly eliminated from the yarn, otherwise it was too inflammable.

Another process, invented by the French and worked by the German, got the cellulose into fluid form by dissolving it in a solution of copper and ammonium salts.

In the making of viscose a third method is employed. Wood pulp, such as is used in paper making, is treated with strong soda lye and then with carbon disulfide. This brings the cellulose into solution as an orange liquid. This is forced through minute holes in a platinum nozzle into dilute acid, which hardens each fine stream into solid fiber and the sulfide is then removed.

During the war another form of soluble cellulose found extensive employment as "scac" or dope for airplane wings. This is the acetate, made by dissolving cotton or wood pulp in the concentrated acid of vinegar, acetic. Lustron is made by this process.

These various kinds of artificial fibers differ from one another and all of them differ from natural silk. And in this difference lies their value. For fabrics can be woven out of natural and artificial silk and with cotton or wool in any desired combination. The fabric at first may look white and uniform, but if it is dipped in baths of various dyes each thread will attach a particular tint and a complicated design brought out in color.

The artificial fibers and the coal-tar dyes make a brilliant combination and through the aid of this alliance our world has become more

colorful and cheerful. Sweaters and hose, neckties and underwear, have blossomed out in varied hue like the flowers that bloom in the spring. The knitting machine has taken a new spurt and is now running a race with the loom. Our ladies may now wear synthetic lace that is shadowed by no thought of toilsome fingers and bent shoulders. They may wear synthetic furs without the sacrifice of wild life.

Man is no longer dependent upon what he can pick up in the plant or animal kingdoms, for the new fiber can be made in any form desired, flat or round, smooth or rough, thick or thin, and of any length. A single filament may be run out thousands of yards without knot or break.

The man-made fiber is not so strong as the worm-made silk, especially when wet, but this has not interfered with its popularity so much as the fact that it is lacking in scroop. The scroop, as the sound of the word suggests, is the audible evidence of the presence of silk. What is the use of owning a silk petticoat if nobody can hear it as you pass by? But science is overcoming even this obstacle.

HOW WORDS LOSE REPUTATION

LANGUAGE is a circulating medium, as money is, and words, like coins, are apt to lose their value in the course of time. A decline in the exchange rating of a word may be due either to inflation, that is, too promiscuous application, or to a growing popular suspicion of the soundness of its backing.

The Seven Wise Men of early Greece were called "sophists" as an honorific appellation. But later a "sophist" came to mean a man who pretended to know more than he did or, worse, who sold his wisdom to the highest bidder for the basest of purposes, that of making a wrong cause seem right.

Pythagoras repudiated the title of sophist, or wise man, because, as he said, "none is wise save God." So he devised and assumed the more modest sounding term of "philosopher," a lover of wisdom. But this term has narrowed, if not degenerated. Philosophy, once the sum total of human knowledge, has come, in common parlance, to be confined to speculative metaphysics. When Plato said that states should be ruled by philosophers he did not mean by professors of metaphysics.

This degenerative process has gone so far that we have no word in good repute and common usage to apply to a group of competent and learned men. The word "scholars" would once have served, but this has fallen from its high estate and come to mean "pupils," that is, those who are being schooled, instead of those who have been schooled. To call a man a "sage" calls up in the average mind the picture of something grey and pedantic, if not green and aromatic. The word "scientist" has become so narrowed and lowered and misapplied that men of science hesitate to use it longer. The titles of "professor" and "expert" are also distinctly losing caste.

To call a man a "fellow" is not safe now-a-days outside of the campus of a university.

It is hard to arrest a word when it is on the down grade and almost impossible for a word to regain a reputation once lost. It seems that some sort of gravitational force prevails in linguistics. The dictionary is crowded with words that once moved in the highest circles, but now are outcast and marked "obs." or "vul."

The man who knows comes in the course of time to be considered a "knowing man," with the suspicion of knowing too much for his neighbors. The "kenning man" becomes the "cunning man." A master of arts gets the reputation of being "artful." A craftsman is regarded as "crafty." A politician has come to mean—well, a politician.

Four hundred years ago the word

NICOLAUS COPERNICUS

The four hundred and fiftieth anniversary of whose birth occurred on February 19. The illustration is from a painting by Brausewetter.

"virago" meant a heroic woman and was esteemed a fitting name to apply to Eve, the mother of all living. Now-a-days no one would dare call a woman a virago to her face if she were one. "Hussy" has degenerated in a hundred years from a thrifty "housewife" to quite the opposite.

In Australian newspapers to-day you may see a lonely bachelor advertising for "a homely wife," not because he has an aversion to feminine beauty, but because he desires domesticity.

A "wretch" was not at all wretched on the start. Othello calls his beloved Desdemona "Excellent wretch." A modern maiden would not feel complimented by such a term of endearment.

A "prude" was merely a prudent person.

A "villain" and a "boor" once meant simply a countryman, not necessarily wicked or even rude. A "knave" was a simple servant. A "varlet" was a candidate for knighthood. A "miscreant" meant one who differed from you in theology.

In 1548 it was proper to express the pious wish "that his son, Prince Edward, that good imp, may long reign over you." How is it that "imp" has since come to mean a little devil?

So, as we see, words generally degenerate as they grow old. That does not matter much, for we can always make new words so long as the alphabet holds out. I am not concerned over the loss of a name, but I am with the loss of the type that the name once signified. If an ancient and honorable title falls into disrepute it is not altogether without reason. It means that some at least of those who bore it have not lived up to its true meaning.

It would be a profitable exercise to consider such cases as occur to us of words that we see are gradually becoming lowered or limited and try to discover the cause of their decline and how it may be prevented.

A DANGEROUS MENTAL MALADY

THE progress of mankind has been in all ages greatly retarded and at times altogether prevented by a curious sort of disease of the mind technically known as neophobia. In a case of hydrophobia the mere sight of water is said to arouse disgust, fear and even furious anger. In a case of neophobia the symptoms are similar but the cause is different. The neophobic patient shows marked aversion and resentment at the sight of anything new. The disease is very prevalent and there are no drugs known that will cure it, except poisons. We all seem to carry about the germs of it, for any of us is liable to manifest mild symptoms, and in certain countries and certain centuries it has been epidemic.

I came across a striking case of neophobia the other day in a letter written in March, 1825, by Thomas Creevey, when a bill for the construction of the first railroad line was introduced into parliament. This is what he felt about it:

> I have come to the conclusion that our Ferguson is *insane*. He quite foamed at the mouth with rage in our Railway Committee in support of this infernal nuisance—the locomotive Monster, carrying *eighty tons* of goods, and navigated by a tail of smoke and sulphur coming thro' every man's grounds between Manchester and Liverpool. . . . Well—this devil of a railway is strangled at last. To-day we had a clear majority in committee in our favour and the promoters of the Bill withdrew it and took their leave of us.

This reminds us of the speech of Sir Charles Napier in the House of Commons when it was proposed to introduce steam power into the navy:

> Mr. Speaker, when we enter Her Majesty's naval service and face the chances of war, we go prepared to be hacked in pieces, to be riddled by bullets or to be blown to bits by shot and shell; but, Mr. Speaker, we do not go prepared to be boiled alive.

The same temper was manifested by the Roman sage, Seneca, when he denounced the waterworks and heating systems that were being intro-

duced into Rome houses and the buildings of several stories that were beginning to appear on the Palatine Hill. "These towering tenements," he said, "are dangerous to the persons who dwell in them." Dangerous to their morals, he meant, of course; not that he was afraid of the buildings falling down. "Believe me," he adds, "that was a happy age before the days of architects, before the days of builders." "A thatched roof once covered free men; under marble and gold dwells slavery." If he had seen a modern thirty-story skyscraper the Latin language would not have been sufficient to express his emotions.

When it was proposed to use coal gas for lighting, Sir Walter Scott called it "a pestilential innovation" and Napoleon considered it "une grande folie" and Byron satirized it in his verse among the passing fads.

When bathtubs were first installed in the United States in the forties the papers attacked them as extravagant and undemocratic and the doctors denounced them as dangerous to health. As usual, government was called upon to restrict or suppress the novelty by special taxes and licenses. In 1843 Virginia put a tax of $30 a year on bathtubs and in 1845 a Boston municipal ordinance made bathing unlawful except on medical advice.

The first printed books had to be sold as manuscripts because of the prejudice against printing. The learned men of Italy sneered at the invention as a barbarous German innovation.

The first shipload of saltpeter sent to England from Chile could not find a buyer and had to be thrown into the sea.

The first bananas shipped to London could not be sold at any price or even given away in the slums, but were left to rot because nobody would eat them.

When they were first introduced into England potatoes were denounced as injurious to society and tomatoes as injurious to morality.

All this is history now and so merely amusing. But it may make us stop a minute to consider if we are to-day opposing some similar innovation from unconscious neophobia.

SCIENTIFIC ITEMS

WE record with regret the death of John Trowbridge, Rumford professor emeritus of physics at Harvard University; of Albert Stowell Flint, astronomer emeritus of the Washburn Observatory, University of Wisconsin; of John Waddell, associate professor of chemistry and librarian of the science department at Queen's University, Kingston; of Fritz Cohn, director of the Berlin Rechen-Institut and professor of theoretical astronomy in the university, and of Johannes Diderik Van der Waals, of the University of Amsterdam, who received the Nobel prize for physics in 1910.

DR. EDOUARD BENJAMIN BAILLAUD, director of the Paris Observatory, has been given the Bruce gold medal, awarded by the Astronomical Society of the Pacific. — The Nichols medal of the American Chemical Society has been awarded to Thomas Midgley, Jr., head of the fuel section of the General Motors Research Corporation laboratories at Dayton, Ohio. — Dr. John Dow Fisher Gilchrist, professor of zoology in the South African College at Capetown, has been elected president of the South African Association for the Advancement of Science for the meeting to be held at Bloemfontein in July.

MR. ARTHUR H. FLEMING, of Pasadena, president of the board of trustees of the California Institute of Technology and its chief financial supporter, has recently given to the institute his fortune of $4,200,000 as a permanent endowment fund. — Sir Alfred Yarrow, an engineer and shipbuilder of Glasgow, has given £100,000 to the Royal Society for the promotion of scientific research.